SECTION E: PRESSURE DISTRIBUTION AND PUMPING SYSTEMS

Part I: Pumping Systems

Pumping Situations
Dosing Tank Specifications
Controls
Wiring
Pump Selection

Part II: Pressure Distribution Systems

Pressure Distribution Network Design

Part III: Dosing Siphons

PART II: PUMPING SYSTEMS

Pumping Situations

Whether it handles sewage or effluent, a pumping station consists of two parts: a dosing chamber and a pump. Never install a pump directly in the septic tank to pump to soil treatment units. The sewage solids will plug either the pump or the soil, causing the either the pump or the soil treatment unit to fail. Install a compartment in the septic tank for the pump or use a separate watertight tank beyond the septic tank to separate solids in the septic tank. Effluent pumps are designed to handle only sewage effluent, which is a relatively clear liquid.

Figure E-1 shows two different pumping situations. The first is a pump located in a separate tank beyond the septic tank. This arrangement is often used in a repair situation where there is an existing septic tank. All sewage wastes are delivered by pump to the drainfield trench system. In the event of pump failure, water use would need to be restricted until the pump can be repaired or replaced.

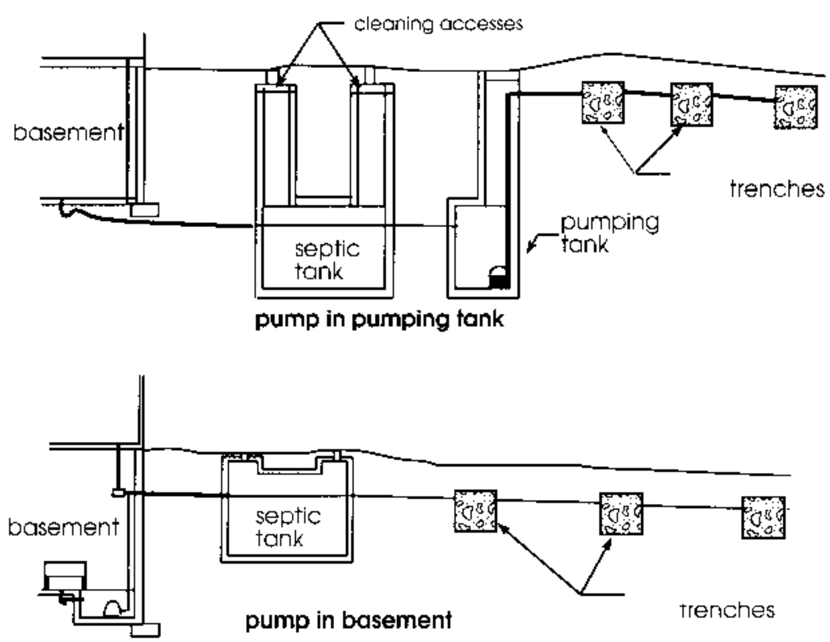


Figure E-1

The cover of the pumping tank, the cover of the septic tank and all cleaning access extensions must be made absolutely watertight to prevent any groundwater from infiltrating the system. Pipe connections to the tanks also must be sealed to be absolutely watertight.

The second situation is a pump located in the basement that delivers laundry tub wastes to the house sewer, from which point the wastes flow by gravity into the septic tank and onto the drainfield trench system. If there is a basement toilet, a sewage ejector or solids handling pump should be used. If sewage solids are pumped, a compartmented tank or two tanks in series should be installed to provide for adequate solids separation. Even though only a portion of the sewage wastes are pumped, there will still be considerable turbulence in the first septic tank when the pump operates. In the event of pump failure, only the basement plumbing could not be used.

The second example also shows that the septic tank is shallow and readily available for cleaning. A tank with a short cleaning access is much easier to clean than a tank with a long cleaning access, such as the one in the first situation. A shallow septic tank is also much less susceptible to groundwater infiltration. It is often less expensive to install a new septic tank at a higher elevation and raise the house sewer line than it is to repair a deep septic tank.

Pumping Effluent

Figure E-2 shows a typical pumping situation where the sewage source is at an elevation lower than where the soil is suitable for sewage treatment. A logical question is why the house was not located at an elevation high enough so that sewage could flow by gravity into the soil treatment unit.

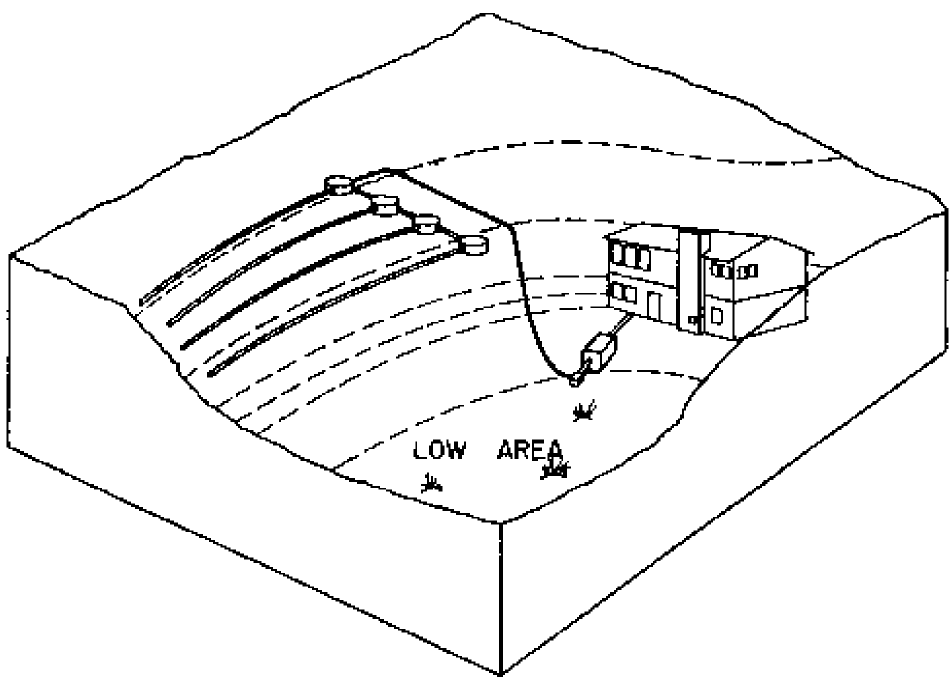
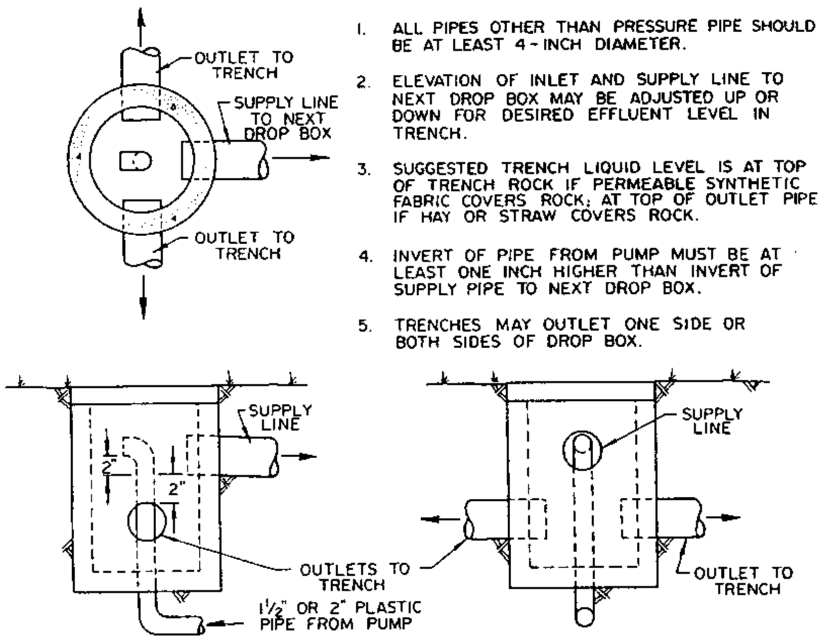


Figure E-2

In some instances, the property owner may want the house at a certain elevation. In other instances, proper planning was not done with respect to the relative location of the house and the sewage treatment system. In the past, many people have incorrectly thought that low areas were suitable for sewage treatment, even though they were too wet for any other purpose.

Note that the pump delivers effluent to a series of trenches using drop box distribution. Figure E-3 shows the first drop box in this system, which accepts the effluent from the pumping station. The bottom of the discharge piping from the pump must be at least two inches higher than the supply line to the next drop box, to avoid any liquid drainback to the pumping station, other than that contained in the pipe from the pump.



DROP BOX FOR PUMPED EFFLUENT

Figure E-3

The discharge line from the pump must be directed to flow against a wall of the drop box where there is no outlet. This placement is necessary to assure that the effluent does not all flow out a single pipe but is instead first distributed to the initial trench, with the remainder then flowing through the supply line to the next drop box

Pumping Raw Sewage

Occasionally it is necessary to pump raw sewage. For example, if a septic tank located next to the source of sewage would be inaccessible for maintenance, which requires the removal of accumulated scum and sludge, it may be more appropriate to pump all sewage solids to a septic tank system in a more accessible location.

Pumps for Raw Sewage

Whenever sewage solids are pumped, a sewage ejector or solids-handling pump must be used. The diameter of the discharge piping must be of the same diameter as the discharge size of the pump. The sewage must flow through the pipe at a velocity of at least two feet per second to transport the solids. The pump must be sized large enough to push the solids through the pipe, a velocity of 2 feet per second is adequate. See the following chart for minimum flows in pipe sizes to carry the solids.

Pipe size	Minimum GPM
1 ½”	12
2”	21
2 ½”	30
3”	46

Ejector Pumps

Solids-handling or **ejector pumps** are commonly installed in basements to pump sewage solids up to a gravity sewer line. The volume of the pump tank must be large enough to accommodate any drainback from the piping, and to effectively dose the system. Whenever such a pump is used to deliver toilet waste to a septic tank, dose volume must be limited to minimize the impact on the tank.

Grinder Pumps

Grinder pumps can are designed for raw sewage. A rotating blade shears or grinds sewage into smaller particles before pumping it. Grinder pumps have a high starting torque and must use a particular type of starting mechanism on the electric motor. In addition, grinder pumps require relatively high maintenance, such as sharpening and replacing bearings. Since all sewage must pass through the grinding mechanism, a grinder pump may experience blockage as the grinding mechanism becomes dull.

Dosing Tank Specifications

The dosing tank is placed between the sewage tank and the lateral system to accumulate effluent. A pump is turned on when the designed dose amount of effluent has collected in the dosing tank, and shuts off when the dose has been delivered. Float switches suspended in the tank usually control the pump. A third switch is used to trigger an alarm when the effluent collected in the dosing tank reaches the emergency level. Proper dosing tank construction, placement and sizing must be considered to ensure reliable system operation.

The dosing tank construction requirements are the same as for sewage tanks. The tank must be durable and watertight and must withstand the soil loads, which push in on the walls. The environment in the tanks is corrosive, so no metal parts or fittings can be used. The major difference between a septic tank and a dosing tank is that the dosing tank will be emptied on a daily basis. **Since the tank will be emptied every day, anchoring it against flotation is critical in areas with a high seasonal or permanent water table.**

Figure E-16: Dosing Tank Recommendations

- Pump tanks must meet or exceed the requirements for sewage tanks see Chapter 69 and be vented.
- At least one maintenance hole, 20 inches in least dimension, must be located directly above the pump, and must extend through the cover to final grade, and be constructed to prevent unauthorized entry.
- The tank must have either an alternating two-pump system or a minimum capacity of 500 gallons or 100% of the average design flow, whichever is greater.
- The pump must have an alarm to warn of failure.
- Pump intakes must be at least four inches from the bottom of the dosing chamber or protected in some other manner to prevent the pump from drawing excessive settled solids.
- There must be access to the pump, pump controls, and pump discharge line without entering the tank.
- Electrical installations must comply with all laws and ordinances, including the latest codes, rules, and regulations of public authorities having jurisdiction, and with the National Electrical Code.

Ensuring that the dosing tank is watertight is also critical. In areas with a high seasonal or permanent water table, groundwater may leak into the dosing tank and overload the system. The seals around the pipes that enter and exit the dosing tank are especially vulnerable to leaks. If the pump is running more than the few minutes a day it takes to pump out the accumulated septic tank effluent, groundwater may be leaking into the septic tank or dosing tank.

Dosing tanks can be round or rectangular. A four-inch to eight-inch concrete block makes a good pedestal for the pump.

Never enter a dosing tank. Any work to replace pumps, switches or connections should be performed from the outside, and the pump, pump controls, and pump discharge line *must* be removable from the surface. The sewage gases produced in the tank can kill a person in a matter of minutes. When working on a tank, make sure the area is well ventilated and someone is standing by. *Never* go into a dosing tank t without a self-contained breathing apparatus to retrieve someone who has accidentally fallen in. While waiting for help, the best thing to do is to put a fan at the top of the tank to blow in fresh air. (See **Section C: Sewage Tanks** for a discussion of safety precautions and practices for working with sewage tanks.)

A complete pumping station with a tank, pump and controls is shown in Figures E-4 and E-5.

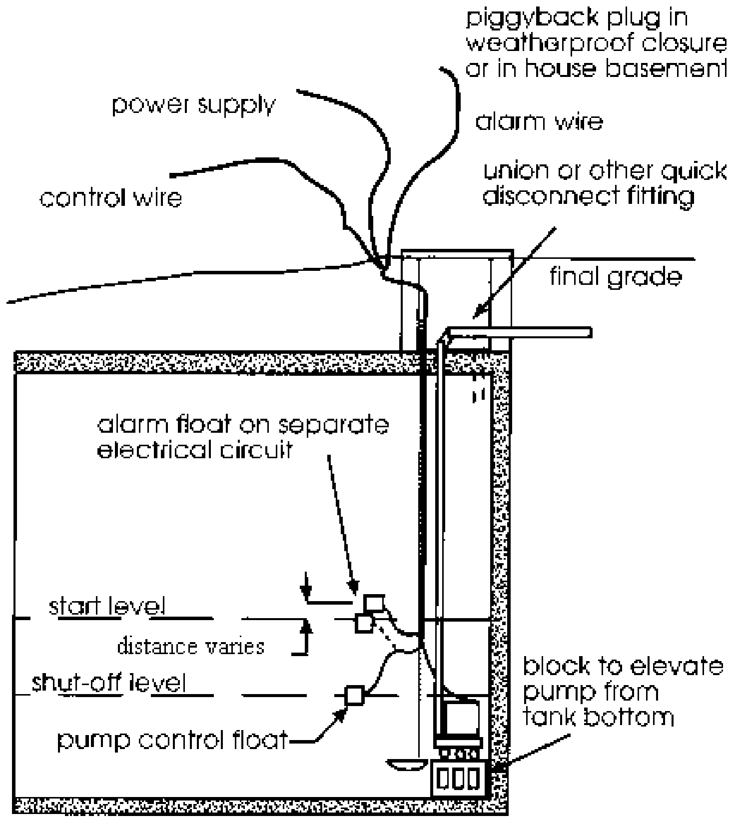


Figure E-4

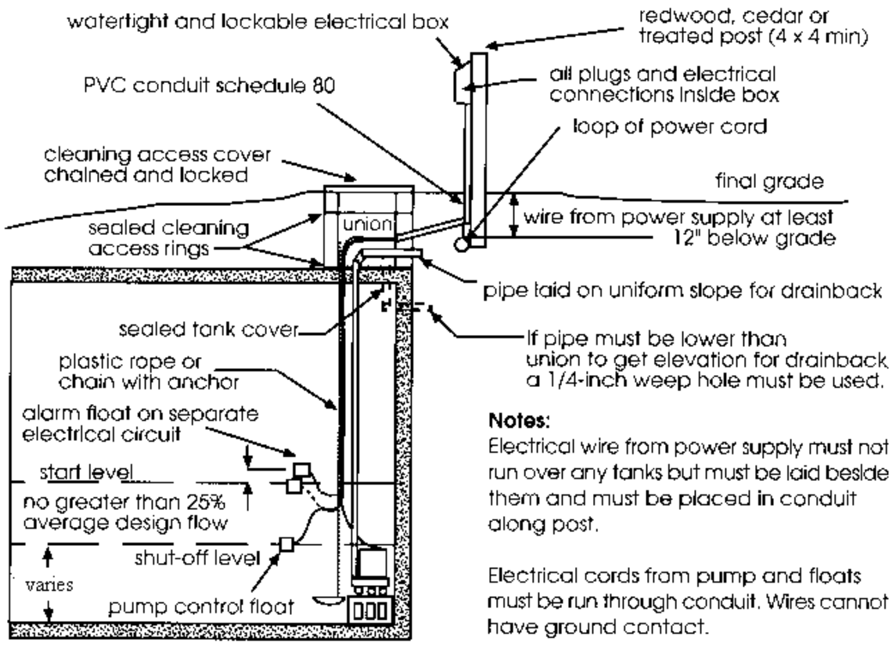


Figure E-5

Cleaning Access Dimensions

The cleaning access's smallest dimension must be at least 20 inches, and preferably 24 inches, for easy access. The cleaning access extension should be 24 inches in diameter. A precast septic tank is often selected for use as the pumping tank. The inlet to this tank can be higher than the normal septic tank inlet, thus providing for additional reserve capacity in the event of pump failure.

Buoyancy

If the pumping tank is installed where the water table is high, consider the problem of tank buoyancy. Be sure the weight of the tank will be adequate to prevent flotation when the tank is nearly empty (which it will be much of the time). Otherwise, anchors may be needed to prevent tank flotation.

Flotation usually is not a problem with a concrete tank but may be with a tank constructed of fiberglass or polyethylene. Such tanks are very likely to need anchoring according to manufacturer's specifications if they are used as a pumping tank in a site with a high water table.

A compartmented tank can help to reduce the buoyancy problem. When a compartmented tank is used, the strength of the inside wall is critical. Since the constant water pressure will be on one side of the wall, the design should be reviewed to avoid failure.

Control Switches for Pumps
Control switches sense the water level in the dosing tank and signal the pump or alarm system. A failure of the control switches can cause sewage to back up into the home or come out the top of the dosing tank. Some switches handle power to the pump directly, while others require a relay. Figure E-6 shows three types of pump controls.

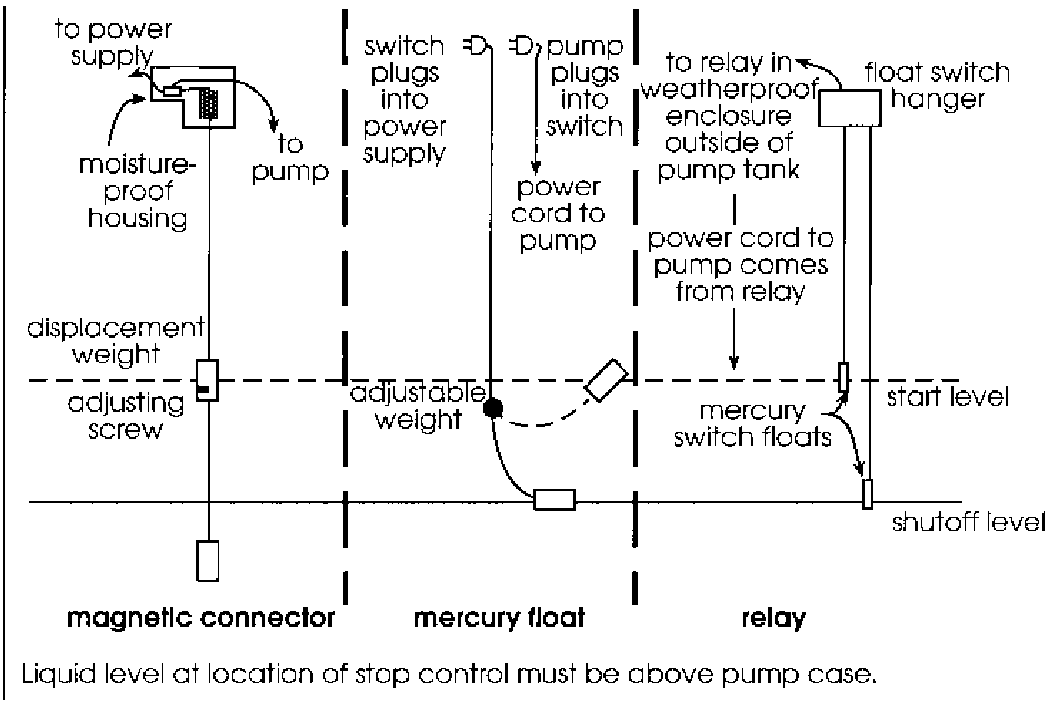


Figure E-6

Mercury switches encased in a plastic or neoprene float are recommended. They are simple and reliable. One switch turns the pump on and a second switch is placed below it to turn the pump off. A third switch is used to activate an alarm if the effluent level exceeds two days storage. The alarm system must be powered in such a way that if the pump circuit fails, the alarm will still operate. Provide a means to turn off the alarm without losing power to the pump.

The distance needed between the on and off switches for a given dose volume depends on the size and shape of the dose tank.

Converting Dose Volume to Distance Between Floats

Cylindrical Tanks
The gallons per inch in a cylindrical tank can be determined by:

$3.14 \times (\text{diameter})^2 \div 4 \times 7.5 \div 12$

If a circular tank of four feet in diameter is used as the pumping tank, the calculation is: $3.14 \times 4^2 \div 4 \times 7.5 \div 12 = 7.85$ gallons per inch

If 150 gallons are to be pumped, float separation is calculated as:

$150 \div 7.85 = 19$ inches

The start control must be set 19 inches higher than the stop control in order to pump out 150 gallons per pump cycle.

Rectangular Tanks

The gallons per inch of depth in a rectangular tank can be determined by:

width x length x $7.5 \div 12$

If a rectangular pumping tank has inside dimensions of four feet by five feet, the volume per depth is:

$5 \times 4 \times 7.5 \div 12 = 12.5$ gallons per inch

To pump 150 gallons, calculate:

$150 \div 12.5 = 12$ inches

The pump start level should be set one foot above the pump stop level.

Drainback

In most domestic applications, the pipe from the pumping station is buried only deep enough to prevent physical damage. It is sloped to drain back to the tank or the distribution system after each pump operation.

Sizing of the pump tank is very important.

For example: a 1.5-foot diameter tank contains 1.08 gallons per inch of depth. Thus, in a ten-inch depth, the volume is 10 x 1.08 = 10.8 gallons, less the actual volume of the pump, which is 2.8 gallons. Eight gallons of wastewater will be pumped out with each pump cycle. And if the pipe is allowed to drain back into the tank when the pump is shut off the actual volume of water that reaches the disposal system is less the pipe volume.

A pumping tank of this size should not be installed in a situation where any drainback occurs. For example, if 50 feet of 2-inch force main are used to the distribution the drain back would be 50 x 0.174 = 8.7 gallons. This amount of water would signal the pump to start again the pump would continue to recycle continuously until it eventually burned out.

Shutoff Level

The shutoff level should be above the body of the pump case, to allow the pump to run while completely submerged for more effective cooling than if the pump body were exposed to air. This placement is particularly important in a pumping tank with a large surface area. Also, there may be a small amount of scum on the surface that would tend to stick to the body of the pump if it were periodically exposed.

Care should be taken that the float switch cannot come to rest on top of the pump, thus preventing the pump from shutting off. In such a situation, the pump would continue to run and be damaged from operating dry

Alarm Float

An alarm float should be located on an electrical circuit separate from the pump to alert the homeowner in case of electrical failure in the pump circuit. The alarm float should be set to activate approximately three inches higher than the pump start level. The alarm mechanism should be both visible and audible, and located where it can be easily seen and heard.

The reserve capacity of the tank is the remaining volume after the alarm sounds.

Electromechanical Devices

There should be no electromechanical devices or connections located in the pumping tank or in the dosing chamber cleaning access because of the risk of corrosion at the connections. The electrical plug-ins should be located in a weatherproof enclosure near the pumping tank or located in a nearby building.

It’s a good idea to attach the control wires to a separate pipe or to a plastic rope or chain with an anchor, so that the control wires can be removed without removing the pump. If the pump has failed, it can be removed without disturbing the control wires.

Provide an outlet for the wires through the side of the cleaning access. Consider installing a section of six-inch plastic pipe with a cap alongside the cleaning access to contain the pumping station wires.

All electrical installations must comply with the National Electric Code.

Wiring Pumping Systems

All wastewater distribution systems that utilize a pump require electrical power and control systems. Proper wiring materials and installation procedures are critical to the safety of the installer, the sewage system users, and all individuals involved in future repairs and maintenance. Adequate wiring ensures reliable pump and system performance. Follow a few basic guidelines to ensure safe and reliable operation at a reasonable cost. In all cases, installation procedures must follow the specifications of the U.S. National Electric Code (NEC). Contact local electrical inspection authorities for permits and inspection requirements. A qualified electrical installer should do the work.

Make no electrical connections inside the dosing tank. This includes plug-ins, screw-type, twisted wire, boxes, relays, or any other type of connection that requires movement to connect or operate. If connections or splices must be made, they should be located in a watertight, corrosion-resistant junction box with watertight, corrosion-resistant fittings and a cover sealed by a gasket.

Materials for Outdoor Wiring

Electrically, there is no difference between wiring inside or outside a building. However, the materials and installation procedures are considerably different. Outdoor wiring must be able to withstand exposure to water, weather, and corrosive environments. This is certainly the case for wiring septic system dosing chambers.

Boxes and Panels

Outdoor equipment used in residential wiring must be weatherproof. The two most common types of weatherproof equipment are driptight and watertight, such as NEMA 2,3, or3R. Driptight equipment seals against water falling vertically. Driptight boxes are usually made of painted sheet metal and have shrouds or shields that deflect rain falling from above. These boxes are not waterproof and should not be used where water can spray or splash on the unit. Driptight boxes are usually used for control or circuit breaker panels.

Watertight boxes seal against water coming from any direction. Individual junction boxes, switch boxes and receptacle boxes will usually be of the watertight type. Watertight boxes are designed to withstand temporary immersion or spray streams from any direction. They are commonly made of cast aluminum, zinc-dipped iron, bronze or heavy plastic and have threaded entries for watertight fittings and covers sealed by gaskets.

Wiring Methods

Two methods, or a combination of the two, are common in outdoor wiring. One method is to place electrical wires inside a conduit. The other is to use cable. In either case, protection from physical damage, water, and corrosion must be provided.

Running wires through sealed conduit provides physical, water, and corrosion protection. Several kinds of conduit are acceptable for outdoor use. Rigid metal conduit made from aluminum or steel provides equivalent wire protection. However, aluminum conduit is not recommended for installation where it is directly in contact with soil. Rigid PVC conduit can be used above ground. High-density polyethylene conduit is suitable for underground installation. Do not use thinwall conduit electrical metallic tubing (EMT) for underground or outdoor installations.

An underground feeder cable can be buried without conduit protection, but physical protection for underground cable is highly recommended to reduce the risk of spading through the cable at a later time. A redwood or treated wood board buried just above the cable is highly recommended to provide physical protection. Do not use nonmetallic cable for underground installations. While it is an excellent material for interior wiring, it will not withstand the moisture conditions in the soil.

Combining the conduit and cable wiring methods is also an option. Conduit can be used around cable for physical protection. Conduit is particularly useful to protect cables where they enter and exit the soil. If conduit and cable are used in combination, appropriate connectors and bushings are needed for transitions from one system to the other. Minimum burial requirements apply to wire in conduit and cables. The size of the wire is determined from the electrical need (the motor size) and the length of wire. Figure E-7 gives wire specifications for various lengths and motor ratings.

Pump and Alarm Control Center

The cables that connect to the pump control switch, alarm switch and pump all originate from the pump and alarm control center. The center should either be placed inside a nearby building or inside a weatherproof box on a post near the entrance port to the dosing tank. Never place the control system inside the dosing tank or riser. The moisture in the dosing tank will cause the system to corrode and fail.

The preferred location for the control and alarm center is indoors, such as in a basement or garage. Conventional indoor wiring material may be used. Order pump and controls with extra-long cables.

When a nearby building is not available, locate the control center in a weatherproof enclosure mounted to a treated wood or steel post near the entrance to the dosing tank. In both cases, it is important to use wire, connectors and weatherproof enclosures appropriate for outdoor use.

A pump motor relay with built-in motor overcurrent protection can be used. The pump motor start and stop switches control the relay coil current. Conduit is used for physical protection of the conductors and cables entering and leaving the box.

A pump motor controlled by the mercury switches and relay built into a plug-in type unit is another option. Overcurrent protection for the motor is supplied by the ground-fault circuit interrupter (GFCI)/circuit breaker combination in a weatherproof enclosure. National Electric Code requirements state that all outdoor outlets of a residence must be GFCI-protected. The GFCI-protected receptacle for the pump power and control circuit should be enclosed in a watertight box. Another alternative is to use a receptacle with built-in GFCI protection and a standard circuit breaker. In either configuration, the alarm system is powered from a separate circuit breaker to prevent tripping the alarm circuit when the pump circuit is tripped.

Figure E-7: Wire Lengths for Pump Motor Ratings

Motor Rating		AWG Copper Wire Size					
volts	**hp**	**14**	**12**	**10**	**8**	**6**	**4**
115	1/3	130	210	340	540	840	1300
	1/2	100	160	250	390	620	960
230	1/3	550	880	1390	2190	3400	5250
	1/2	400	650	1020	1610	2510	3880
	3/4	300	480	760	1200	1870	2890
	1	250	400	630	990	1540	2380
	1-1/2	190	310	480	770	1200	1870
	2	150	250	390	620	970	1530
	3	120*	190	300	470	750	1190
	5	0	0	180	280	450	710
	7-1/2	0	0	0	200*	310	490
	10	0	0	0	160*	250*	390
	15	0	0	0	0	170*	270*

2- or 3-wire cable, maximum length in feet, service entrance to motor

*Lengths meet U.S. National Electric Code (NEC) ampacity only for individual conductor 60C cable in free air or water, not in conduit. If cable rated other than 60C is used, lengths remain unchanged, but minimum size acceptable for each rating must be based on the NEC table column for that temperature cable.

Lengths without asterisks meet NEC ampacity for individual conductors and jacketed 60C cable. Flat molded cable is considered jacketed cable.

Maximum lengths shown maintain motor voltage at 95% service entrance voltage, running at maximum nameplate amperes. If service entrance voltage will be at least motor nameplate voltage under normal load conditions, 50% additional length is permissible for all sizes.

Table based on copper wire. If aluminum wire is used, it must be two sizes larger. If table calls for #12 copper, for example #10 aluminum would be required.

Wiring from the Pump and Alarm Controls to the Pump and Switches

The power cable to the pump and float switch cables running from the control center into the tank should be run in conduit (metal or PVC) where physical protection is needed. The area around the conduit entering the tank should be sealed to prevent surface water from entering the tank through the conduit. If the conduit provides a continuous connection between the control center box and the tank, the conduit entrance to the box should be plugged with electrical putty to prevent the movement of moisture and corrosive gases into the control box.

Power cables used in these installations, such as Types SE, SJ or SOW, must be suitable for moist and corrosive environments. The power cable to the pump must have a grounding conductor (usually a green insulated wire) to ground the pump motor frame. Metallic conduit should not be used for equipment grounding to or within the tank. Since the pump is considered a motor load, it must have appropriate disconnecting means. The disconnect for units of one horsepower or greater (circuit breaker or switch) must be clearly marked and either in sight of the pump location or lockable. This prevents inadvertent reactivation of the circuit during servicing of the unit. Below one hp, receptacles and plugs listed for motor loads (hp listed) may be used.

Power Supply to the Pump and Alarm System Control Center

Power to the pump and alarm system control center, when located outside a building, will most frequently be supplied by an underground branch circuit from a nearby service entrance or sub-panel. Follow electrical code specifications for materials and burial depths as described earlier. Avoid routing buried wiring through existing or anticipated gardens or landscaping areas to minimize the chances of damage due to spading.

Power to the control center should be from a single individual branch circuit with no other loads. The circuit breaker or fuse supplying this circuit should be clearly marked at the service entrance location.

Pump Selection

Factors that affect pressure and are:

- How high do you need to lift the water?
- How fast do you need to move the water?
- How much pipe and what size pipe do you plan to pump the water through?
- What fittings do you have downstream of the pump?
- How much pressure do you want when you get to the end of the pipe?

- How high do you need to lift the water?

This is the vertical distance from the water level in the tank to the discharge point. This is also called the STATIC HEAD. See Figure E-8.

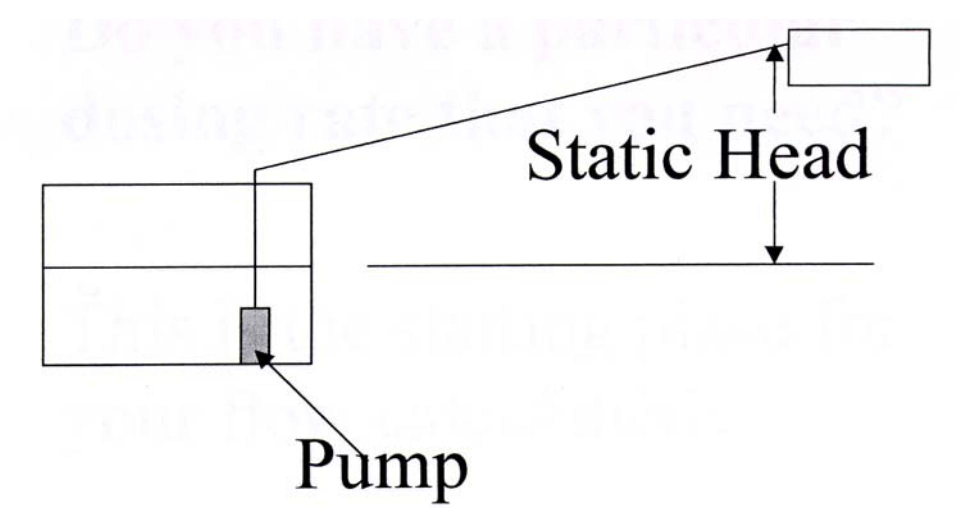


Figure E-8

- How fast do you need to move the water?

Do you need to pump 10 gallons per minute (gpm), 20 gpm or 100 gpm? Is there a particular rate of flow needed for the application? This is the starting place for the flow calculations.

When pumping raw wastewater, water with solids the pump must be sized large enough to push the solids through the pipe, a velocity of 2 feet per second is adequate. See the following chart for minimum flows in pipe sizes to carry the solids.

Pipe size	Minimum GPM
1 ½”	12
2”	21
2 ½”	30
3”	46

- How much pipe and what size pipe do you plan to pump the water through?

The pipe size and flow rate affect the Headloss. Headloss is the pressure that is used to transport the water from one point to another. The higher the flow rate the higher the headloss, so the pump needs to produce more pressure the higher the flow to maintain the same pressure at the end of the pipe.

Headloss varies with the pipe size. The smaller the pipe the higher the headloss, therefore the pump needs to produce more pressure in smaller pipes at the same flow rate to provide the same pressure at the end of the pipe for the same flow rate.

Examples:

15 gpm, 100 ft of 2” pipe Headloss (HL) = 0.48 ft

25 gpm, 100 ft of 2” pipe HL = 1.11 ft

25 gpm, 100 ft of 3” pipe HL = 0.16 ft

In addition the longer the pipe the greater the Headloss.

Examples:

25 gpm, 100 ft of 2” pipe HL = 1.11 ft

25 gpm, 350 ft of 2” pipe HL = 3.88 ft
(this is obtained by multiplying 1.11 x 3.5 = 3.88)

These values come from Figure E-9. There are many types of pipes and schedules of pipe be sure to use the correct chart for the type of pipe used.

Figure E-9: Head Loss Due to Friction in Plastic Pipe (c=150)							
flow rate (gpm)	nominal pipe diameter						
	1”	1.25”	1.5”	2”	2.5”	3”	4”
inside dia. gals/100ft.	1.05” 4.49	1.38” 7.77	1.61” 10.58	2.067” 17.43	2.47” 24.87	3.07” 38.4	4.03” 66.1
1	0.08						
2	0.25						
3	0.59	0.16					
4	1.01	0.27					
5	1.53	0.40	0.19				
6	2.14	0.56	0.27				
7	2.85	0.75	0.35	0.11			
8	3.65	0.96	0.45	0.13			
9	4.53	1.19	0.56	0.17			
10	5.51	1.45	0.69	0.20	0.09		
12	7.72	2.03	0.96	0.28	0.12		
14	10.27	2.70	1.28	0.38	0.16		
16	13.14	3.46	1.63	0.48	0.20		
18		4.30	2.03	0.60	0.25		
20		5.23	2.47	0.73	0.31	0.11	
25		7.90	3.73	1.11	0.47	0.16	
30		11.07	5.23	1.55	0.65	0.23	
35		14.73	6.96	2.06	0.87	0.30	
40			8.91	2.64	1.11	0.39	0.10
45			11.07	3.28	1.38	0.48	0.13
50			13.46	3.99	1.68	0.58	0.16
55				4.76	2.00	0.70	0.19
60				5.60	2.35	0.82	0.22
65				6.48	2.73	0.95	0.25
70				7.44	3.13	1.09	0.29
80				9.52	4.01	1.39	0.37
90				11.84	4.98	1.73	0.46
100				14.38	6.06	2.11	0.56
125					9.15	3.18	0.85
150					12.83	4.46	1.19
175					17.06	5.93	1.58
200						7.59	2.02

- What fittings do you have downstream of the pump?

Generally the pump is followed by bends, valves, check valves, or a union. Each of these fittings causes some friction loss as the water flows through it. There are charts that convert the fitting type and size to an equivalent length of pipe size. Then this equivalent length can be added to the pipe length for determine the headloss due to the pipe and fitings. Figure E-10 is used to convert the fittings.

Example: 2" plastic coupling = 3 ft of 2" pipe
2" plastic 90 bend = 9 ft of 2" pipe

Figure E-10: Equivalent Length of Pipe

		Nominal size of fitting and pipe (equivalent length in feet)						
type of fitting and application	**pipe and fitting material[1]**	**½"**	**¾"**	**1"**	**1 ¼"**	**1 ½"**	**2"**	**2 ½"**
insert coupling	plastic	3'	3'	3'	3'	3'	3'	3'
threaded adapter	copper	1'	1'	1'	1'	1'	1'	1'
plastic or copper to thread	plastic	3'	3'	3'	3'	3'	3'	3'
90° standard elbow	steel	2'	3'	3'	4'	4'	5'	6'
	copper	2'	3'	3'	4'	4'	5'	6'
	plastic	4'	4'	6'	7'	8'	9'	10'
standard tee, straight flow thru run	steel	1'	2'	2'	3'	3'	4'	5'
	copper	1'	2'	2'	3'	3'	4'	5'
	plastic	4'	4'	4'	5'	6'	7'	8'
gate or ball valve[2]	steel	2'	3'	4'	5'	6'	7'	8'
swing checkvalve[2]	steel	4'	5'	7'	9'	11'	13'	16'
globe valve	steel	15'	20'	25'	35'	45'	55'	65'
30-gal vertical water heater	----	4'	17'	56'				

[1] Loss figures are based on equivalent lengths of indicated pipe material.

[2] Loss figures are for screwed valves, and are based on equivalent lengths of steel pipe.

Table from MWPS-14 "Private Water Systems," Midwest Plan Service, Iowa State University, Ames, Iowa.

- How much pressure do you want when you get to the end of the pipe?

This is the squirt height you want at the end of the pipe. If you are dumping the water into a distribution box then you a very low squirt height, less than 1 foot, if you are using a pressure distribution system then you want at least 2-3 feet.

An example of putting a system all together Figure E-11:

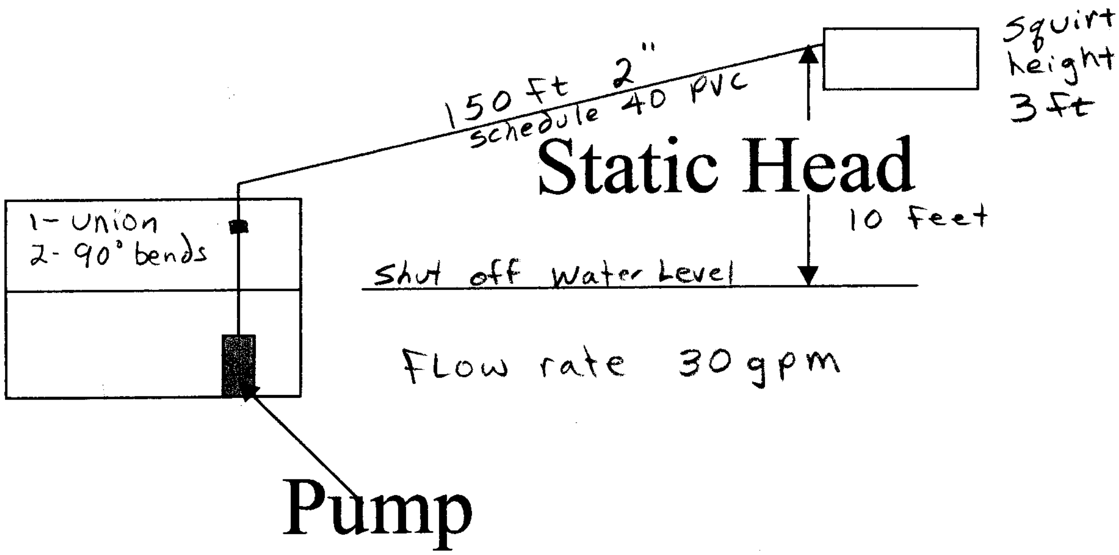


Figure E-11

Flow rate required 30 gpm

Static head	=10 ft
Squirt height	= 3 ft

1-2"coupling	= 2x3	= 6 ft ft
2-2" bends	= 2x9	= 18 ft
		= 150 ft pipe
Total pipe equivalent length		= 174 ft.

From Figure E-9 30 gpm in 2"pipe HL is 1.55 ft per 100 feet
Headloss due to pipe and fittings is 1.55 x 1.74 = 2.70 ft
Therefore the total head that the pump needs to produce is

Elevation difference	= 10 ft
Squirt height	= 3 ft
Pipe losses	= 2.7 ft

Total Dynamic Head = 15.7 ft at 30 gpm
At different flow rates there will be different head losses. When these are calculated and plotted on a graph this is called a **system curve**. This is the flow vs headloss for a given pipe system.

From the example above the system curve is

At 20 gpm 14.2 ft	At 30 gpm 15.7 ft
At 40 gpm 17.6 ft	At 50 gpm 20 ft
At 60 gpm 22.7 ft	

A system of pipes, fittings, static head, squirt height can ONLY operate on its system curve.

Pump Curves: The pump performance curve shows the pumping rate (gpm) that a pump will produce against a particular head (pressure). For examples used here we are using centrifugal pumps.

You can pump hard, high head low flow, or you can pump fast, high flow and low head.

A pump can ONLY operate on its performance curve.

The challenge is to match the SYSTEM CURVE up to a PUMP CURVE. This is called the operating point, this is where the two intersect. See Figure E-12.

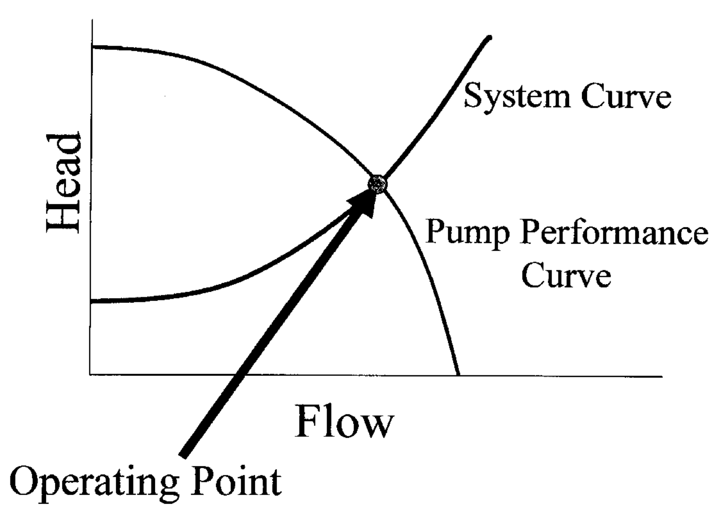


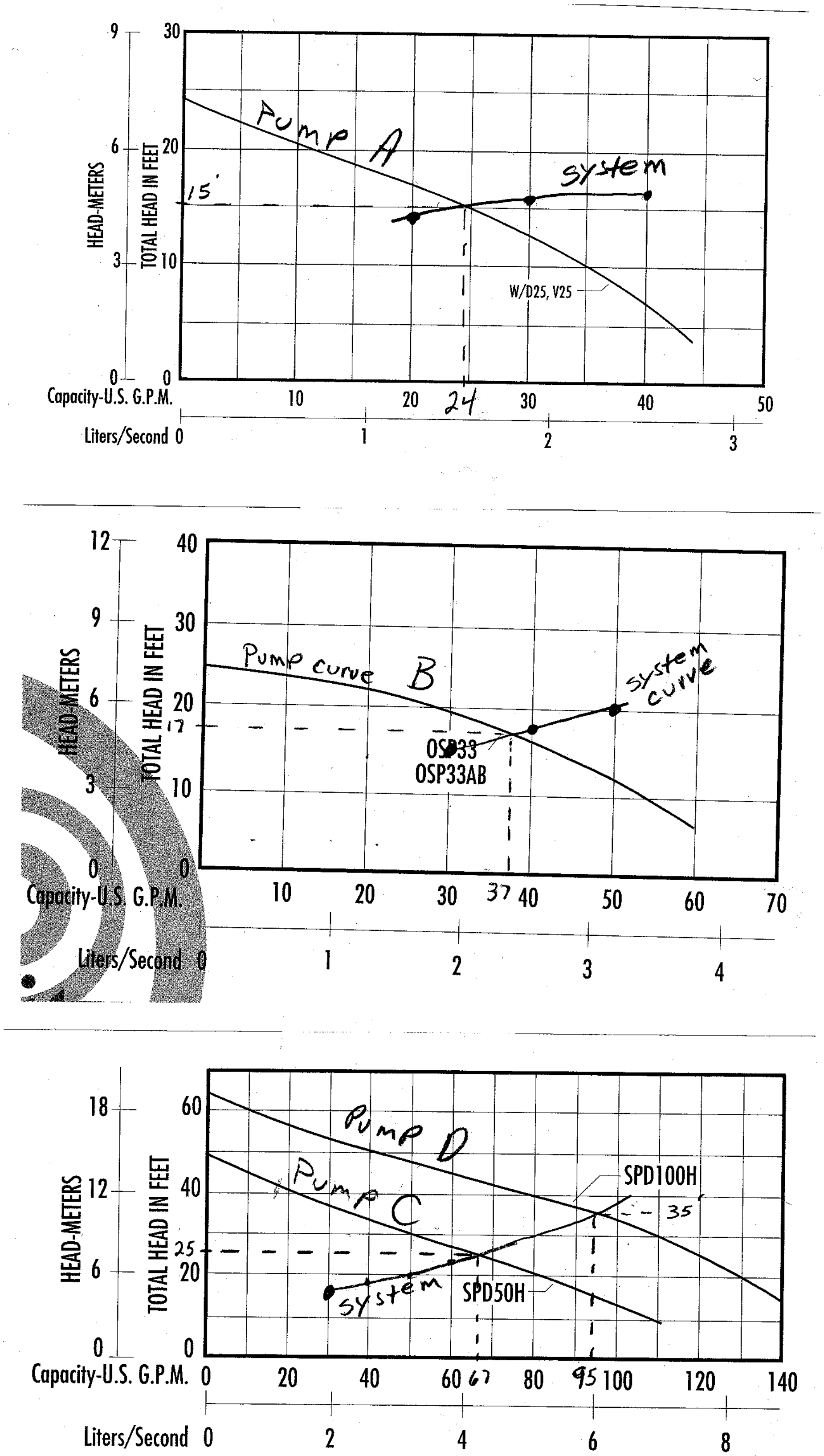
Figure E-12

The pump curve can not be below the operating point that you want the system to operate at. Pick a pump and pump curve that is as close to the operating point but above the point as possible.

Plotting each of these on pump curves reveals the following in Figure E-13. If these were the only pumps available then a decision must be made on which pump to use.

> Pump A only produces 15 feet of at 24 gpm which is below the required. This pump should be rejected.
>
> Pump B will provide 17 feet at 37 gpm. This will exceed the minimum by a small amount and will work.
>
> Pump C will provide 25 feet at 67 gpm. This far exceeds the needs of the system, and is rejected
>
> Pump D will provide 35 feet at 95 gpm. This far exceeds the needs of the system, and is rejected.

Pump B should be selected for the job.



HEAD-METERS
TOTAL HEAD IN FEET
Pump A
system
15'
W/D25, V25
24
Capacity-U.S. G.P.M.
Liters/Second
Pump curve B
system curve
17
OSP33
OSP33AB
37
Pump D
Pump C
SPD100H
35'
25
system
SPD50H
67
95

Figure E-13

Every project or system has its own needs and must be designed individually. Do not assume that this project is similar to the last one therefore the same pump will work. Identify all of the variables and design a system and pump to fit the project. Ask the dealer or the manufacture for assistance in designing the system they are more than glad to help.

Look for booklets on sizing and trouble shooting pump systems they are very helpful.

A good example is the

THE PROBLEM SOLVER, By STA-RITE call 800-525-6090

PART II: PRESSURE DISTRIBUTION SYSTEMS

This section examines the dosing chamber and distribution system that conveys the septic tank effluent to the secondary treatment system for treatment and disposal. The discussions on design and construction are intended to enable health officials and contractors to design, construct, and inspect pressure distribution systems.

Use pressure distribution for all mounds, at-grade systems, recommended for sand filters.

Uniform Distribution

Septic tank effluent is distributed through a series of perforated pipes. **Uniform distribution** of the septic tank effluent in the above-mentioned situations is very important. Uneven distribution of effluent can result in localized overloading and the system may fail.

Uniform distribution is achieved using a pressure distribution system. Pressure distribution systems are carefully designed so that the volume of septic tank effluent flowing out of each hole of the distribution pipe is **nearly identical**. The pipe diameters and hole diameters must be carefully sized to achieve uniform distribution.

Pressure distribution systems consist of five components:

- lateral pipes with holes drilled into the pipe,
- manifold and main connected to the laterals,
- dosing tank to collect septic tank effluent to be pumped to the treatment system,
- pump or dosing siphon to pressurize the system, and
- controls and power supply to operate the pump.

Steps to design and construct these components will be presented in this section. The following is a paper by Jim Converse on how to design a pressure distribution system.

PRESSURE DISTRIBUTION NETWORK DESIGN

By

James C. Converse[1]
January, 2000

Septic tank effluent or other pretreated effluent can be distributed in a soil treatment/dispersal unit either by trickle, dosing or uniform distribution. **Trickle flow**, known as gravity flow, occurs each time wastewater enters the system through 4" perforated pipe. The pipe does not distribute the effluent uniformly but concentrates it in several areas of the absorption unit. **Dosing** is defined as pumping or siphoning a large quantity of effluent into the 4" inch perforated pipe for distribution within the soil absorption area. It does not give uniform distribution but does spread the effluent over a larger area than does gravity flow. Uniform distribution, known as pressure distribution, **distributes the effluent somewhat uniformly throughout the absorption area.** This is accomplished by pressurizing relatively small diameter pipes containing small diameter perforations spaced uniformly throughout the network and matching a pump or siphon to the network.

This material has been extracted and modified from a paper entitled "Design of Pressure Distribution Networks for Septic Tank- Soil Absorption Systems" by Otis, 1981. It also includes material from the "Pressure Distribution Component Manual for Private Onsite Wastewater Treatment Systems" by the State of Wisconsin, Department of Commerce, 1999.

Design Procedure

The design procedure is divided into two sections. The first part consists of sizing the distribution network which distributes the effluent in the aggregate and consists of the laterals, perforations and manifold. The second part consists of sizing the force main, pressurization unit and dose chamber and selecting controls.

A. Design of the Distribution Network:

Steps

1. **Configuration of the network.**

   The configuration and size of the soil treatment/dispersal unit must meet the soil site criteria. Once that has been established, the distribution network can be designed.

---

[1]James C. Converse, Professor, Biological Systems Engineering, University of Wisconsin-Madison. Member of Small Scale Waste Management Project.

2. Determine the length of the laterals.

Lateral lengths are defined as the distance length from the manifold to the end of the lateral. For a center manifold it is approximately than one half the length of the absorption area. For end manifolds it is approximately the length of the absorption area. The lateral end about 6" to 12" from the end of the absorption units.

3. Determine the perforation size, spacing, and position.

The size of the perforation or orifices, spacing of the orifices and the number of orifices must be matched with the flow rate to the network.

Size: The typical perforation diameter has been 1/4" but, with the advent of the effluent filters, placed in septic tanks to eliminate carry-over of large particles, smaller diameter orifices can be used. Orifices as small as 1/8" are commonly used in sand filter design utilizing orifice shields to protect the orifice from being covered with aggregate. There are also concerns about using the 1/8" orifices as to how well they drain when located downward especially if they have been drilled in the field. Shop drilling the orifices under tight specifications reduces the concern. As a compromise, one might consider using 3/16" diameter orifices which will allow for more orifices than if 1/4" diameter orifices were used. This example will use 3/16" diameter orifices. **A sharp drill bit will drill a much more uniform orifice than a dull drill. Replace drills often. Remove all burrs and filing from pipe before assembling it.**

Spacing: It is important to distribute the effluent as uniformly as possible over the surface to increase effluent/soil contact time to maximize treatment efficiency. Typical spacing has been 30-36" but some designers have set spacing further apart to reduce pipe and pump sizes. Typical spacing for sand filters has been 6 ft^2/orifice. This spacing is being adopted in the Wisconsin Code (1999) for all pressure distribution applications. This example will use the 6 ft^2/orifice.

Positioning: In cold climates, it is essential that the laterals drain after each dose event to prevent freezing. In sand filters, the orifices have been placed upward with the orifice protected with an orifice shield. The laterals are sloped back to the force main for drainage after each dose. Because of the longer laterals normally encountered in mounds the orifices are typically placed downward for draining as it is much more difficult to slope the lateral to the manifold/force main because of their greater length than found in sand filters. However it can be done. The designer/installer may want to consider sloping the pipe back to the manifold, placing the orifices upward with orifice shields or placing a 3 or 4" half pipe over the entire length of the lateral. Another alternative is placing the lateral inside a 4" perforated pipe with orifices downward or with orifices upward and pipe sloped to the manifold.

4. Determine the lateral pipe diameter.

Based on the selected perforation size and spacing, Fig. A-1 through A-3 will be used to select the lateral diameter.

5. Determine the number of perforations per lateral.

Use $N = (p/x) + 0.5$ for center feed/center manifold or $N = (p/x) + 1$ for end fed/end manifold where N = number of perforations, p= lateral length in feet and x= perforation spacing in feet. Round number off to the nearest whole number.

6. Determine the lateral discharge rate.

Based on the distal pressure selected, Table A-1 gives the perforation discharge rate. Recommended distal pressures are 2.5 ft for 1/4" orifices, 3.5 ft for 3/16" orifices and 5 ft for 1.8" orifices. The head that the system operates under is controlled where the system curve interacts with the pump curve (Fig. A-4). For this example use 3.5 ft of head.

7. Determine the number of laterals and the spacing between laterals.

Since the criteria of 6 ft^2/orifice is the guideline, the orifice spacing and laterals spacing are interrelated. For absorption area widths of 3 ft, one distribution pipe along the length requires an orifice spacing of 2 ft. For a 6 ft wide absorption area with the same configuration it would require orifice spacing of 1 ft. **Ideally, the best option is to position the perforations to serve a square such as a 2.5 by 2.5 area** but that may be difficult to do but a 2 by 3 is much better than a 6 by 1 area.

8. Calculate the manifold size and length.

The manifold length is the same as the spacing between the outer laterals if the force main comes into the manifold end. For smaller units assume the manifold size is the same as the force main diameter since the manifold is an extension of the force main. There are procedures for determining the manifold size for larger systems (Otis, 1981).

9. Determine the network discharge rate.

This value is used to size the pump or siphon. Take the lateral discharge rate and multiply it by the number of laterals or take the perforation discharge rate and multiply it by the number of perforations.

10. Provide for Flushing of Laterals.

Provisions must be made to flush the laterals periodically, preferably annually. Easy access to lateral ends is essential otherwise, the flushing will not be done. Turn-ups, as used in sand filter technology, is one approach.

B. Design of the Force Main, Pressurization Unit (Pump or Siphon), Dose Chamber and Controls.

Steps

1. Develop a system performance curve.

The system performance curve predicts how the distribution system performs under various flow rates and heads. The flow rate is a function of the total head that the pump works against. As the head becomes larger, the flow rate decreases but the flow rate determines the network pressure and thus the relative uniformity of discharge throughout the distribution network. The best way to select the pump is to evaluate the system performance curve and the pump performance curve. Where the two curves cross, is where the system operates relative to flow rate and head.

The total dynamic head that the pump must work against is the:

1. System network head (1.3 x distal pressure with minimum 2.5 ft.).
2. Elevation difference between the off-float and the highest point in the network.
3. Friction loss in the force main.

The system network head is the pressure maintained in the system during operation to assure relatively uniform flow through the orifices. The 1.3 multiplier relates to the friction loss in the manifold and laterals which assumes that the laterals and manifold are sized correctly. The elevation difference is between the pump off switch and the distribution network in feet (the pump industry uses the bottom of the pump to the net work). The friction loss in the force main between the dose chamber and the inlet to the network is determined by using Table A-2. Equivalent length for fittings should be included but have typically been ignored. They are included in the example problem with equivalent lengths found in Table A-3.

2. Determine the force main diameter.

The force main diameter is determined in Step 1, part B.

3. Select the pressurization unit.

Pumps

The effluent pumps used for pressurizing the distribution networks are either centrifugal effluent pumps or turbine effluent pumps. The turbine effluent pump, which is a sightly modified well pump, is relatively new to the on-site industry. Relatively speaking the centrifugal pump is a higher capacity/ lower head pump with a relatively flat performance curve and the turbine pump is a lower capacity/higher head pump with a relatively steep performance curve. Turbine pumps probably have a longer life. They may be the preferred choice for time dosing because of their longevity relative to stop/starts.

Using pump performance curves, select the pump that best matches the required flow rate at the operating head. Plot the pump performance curve on the system curve. Then determine if the pump will produce the flow rate at the required head. Do not undersize the pump. It can be oversized but will be more costly.

Siphons

Care must be taken in sizing siphons. The head that the network operates against has to be developed in the force main by backing effluent up in the pipe. If the discharge rate out the perforations is greater than the siphon flow rate, the distal pressure in the network will not be sufficient. Some manufacturers recommend that the force main be one size larger than the siphon diameter to allow the air in the force main to escape. However, this will reduce the distal pressure in the network which may be below the design distal pressure. Falkowski and Converse, 1988, discuss siphon performance and design.

4. Determine the dose volume required.

The lateral pipe volume determines the minimum dose volume. The recommended dose volume has been 5 - 10 times the lateral volume. Also, it was recommended that the system be dosed 4 times daily based on the design flow which would be about 113 gpdose (450 gpd/ 4). At this rate, some mounds would only be dosed once a day. With the advent of timed dosing where effluent is applied a number of times per day, smaller doses need to be applied. However, sufficient volume needs to be applied to distribute the effluent uniformly across the network. Thus, net dose volume size is 5 times the lateral pipe volume with not over 20% of the design volume/dose. The floats are set based on the net dose volume plus the flow back. Table A-4 gives the void volume for various size pipes.

5. Size the dose chamber.

The dose chamber (Fig. A-5) must be large enough to provide:

a. The dose volume.
b. The dead space resulting from placement of the pump on a concrete block.
c. A few inches of head space for floats
d. Reserve capacity based on 100 gallons per bedroom.

If time dosing is selected, the pump chamber or septic tank/pump chamber must have sufficient surge capacity. The reserve capacity normally would be sufficient to handle it in a pump chamber. However, if a turbine pump is used, there may not be enough surge capacity if the pump must be submerged as turbine pumps are relatively tall. If the liquid level needs to be above the pump, sufficient dead space reduces the working volume of the tank. That is not the case for centrifugal pumps.

6. Select controls and alarms.

Select quality controls and alarms. Follow electrical code for electrical connections. Some have to be made outside the dose tank. There are excellent friendly user control panels for timed dosed systems.

DESIGN EXAMPLE

Design a pressure distribution network for the mound as described in the Wisconsin Mound Soil Absorption System Siting, Design and Construction (Converse and Tyler, 2000). The absorption area is 113 ft long by 4 ft wide. The force main is 125 ft long and the elevation difference is 9 ft with three 90° elbows.

A. Design of the distribution network.

Steps:

1. Configuration of the network.

This is a narrow absorption unit on a sloping site.

2. Determine the lateral length.

Use a center feed, the lateral length is:

Lateral Length = (B / 2) - 0.5 ft Where: B = absorption length.

= (113 / 2) - 0.5 ft
= 56 ft

3. Determine the perforation spacing and size.

Perforation spacing -

Each perforation covers a maximum area of 6 ft^2. The absorption area is 4 ft wide.

Option 1: **Two laterals** on each side of the center feed

Spacing = (area/orifice x no. of laterals / (absorption area width)

= (6 ft^2 x 2) / (4 ft)
= 3 ft.

Option 2: **One lateral** down the center on each side of the center feed:

Spacing = area per orifice / width of absorption area

= 6 ft^2 / 4 ft = 1.5 ft

Best option: - Ideally, the best option is to position the perforations to serve a square but that may be difficult to do. In Option 1, each perforation serves a 2' by 3' rectangular area while in option 2, each perforation serves a 1.5 by 4 area. With an absorption area of 6 ft wide with one lateral down the center, perforation spacing would be 1 ft apart and the perforation would serve an area of 6 by 1 ft **which would be undesirable**. The proposed Comm. 83 code (Wisc Adm. Code, 1999) states that laterals have to be within 2.0 ft of the edge of the absorption area to eliminate designs laterals with close spacings.

Perforation size -

Select from 1/8, 3/16 or 1/4". Use 3/16" as per discussion in section "Design Procedure Item A-3.

4. Determine the lateral diameter.

Using **Fig. A-2 (3/16")**:

Option 1: For **two laterals** on each side of the center feed and lateral length of 56 ft and 3.0 ft spacing, the **lateral diameter = 1.5"**

Option 2: For one lateral on each side of center feed and lateral length of 56 ft and 1.5 ft spacing, **the lateral diameter = 2".**

5. Determine number of perforations per lateral and number of perforations.

Option 1: Using 3.0 ft spacing in 56 ft yields:

$N = (p/x) + 0.5 = (56 / 3.0) + 0.5 = 19$ perforations/lateral

Number of perforations = 4 lateral x 19 perforations/lateral = 76

Option 2: Using 1.5 ft spacing in 56 ft yields:

$N = (p/x) + 0.5 = (56/ 1.5) + 0.5 = 38$ perforations/ lateral

Number of perforations = 2 laterals x 38 perforations/lateral = 76

Check - Maximum of 6 ft^2 / perforation =

Number of perforations = 113 ft x 4 ft / 6 ft^2 = 75 so ok.

6. Determine lateral discharge rate (LDR).

Using network pressure (distal) pressure of 3.5 ft and 3/16" diameter perforations, Table A-1 gives a discharge rate of 0.78 gpm regardless of the number of laterals.

Option 1: LDR = 0.78 gpm/ perforation x 19 perforations = 14.8 gpm

Option 2: LDR = 0.78 gpm/ perforation x 38 perforation = 29.6 gpm

7. Determine the number of laterals.

This was determined in Step 3 and 4.

Option 1: Two laterals on each side of center feed = 4 laterals spaced 2 ft apart.

Option 2: One lateral on each side of center feed = 2 laterals down center of absorption area.

8. Calculate the manifold size.

Option 1. The manifold is same size as force main as it is an extension of the force main or it could be one size smaller. For larger systems, there is a table available by Otis, 1981 and Wisc. Adm. Code.

Option 2. There is no manifold.

9. Determine network discharge rate (NDR)

Option 1. NDR = 4 laterals x 14.8 gpm/lateral = 59.2 or 60 gpm

Option 2. NDR = 2 laterals x 29.6 gpm/lateral = 59.2 or 60 gpm

Pump has to discharge a minimum of 60 gpm against a total dynamic head yet to be determined.

10. Total dynamic head.

Sum of the following:

System head = 1.3 x distal head (ft)
= 1.3 x 3.5 ft
= 4.5 ft

Elevation head = 9.0 ft (Pump shut off to network elevation)

Head Loss in Force Main = Table A-2 and A-3 for 60 gallons and 125 ft of force main and 3 elbows.

Equivalent length of pipe for fittings - Table A-3

Option A: 2" diameter force main = 3 elbows @ 9.0 ft each = 27 ft of pipe equivalent.

Option B: 3" diameter force main = 3 elbows @ 12.0 ft each = 36 ft

Head Loss = Table A-2

Option A: 2" diameter force main = 7.0 (125 ft + 27 ft)/100 =
= 10.6 ft

Option B: 3" diameter force main = 0.97(125 ft + 36 ft) 100 =
= 1.6 ft

Total Dynamic Head (TDH)

Option A: TDH = 4.5 + 9 + 10.6 = 24.1 ft (2" force main)

Option B: TDH = 4.5 + 9 + 1.6 = 15.1 ft (3" force main)

11. Pump Summary

Option A: Pump must discharge 60 gpm against a head of 24.1 with 2" force main.

Option B: Pump must discharge 60 gpm against a head of 15.1 ft with 3" force main.

These are the calculated flow and head values. The actual flow and head will be determined by the pump selected. A system performance curve plotted against the pump performance curve will give a better estimate of the flow rate and total dynamic head the system will operate under. The next section gives an example.

Design of the Force Main, Pressurization Unit, Dose Chamber and Controls

Steps

1. **Calculate the system performance curve.**

Use the following table to develop a system performance curve. Follow procedures (a) through (g) which is listed below the table. Orifice is synonymous to perforation. **This example uses Option A. Option B can be calculated similarly.**

Total Flow	Orifice Flow	Elevation Difference	Force Main	Network Head	Total Head
-------(gpm)-----------		---------------------------(ft)---------------------------------------			
40	0.526	9	5.0	2.1	16.1
50	0.658	9	7.6	3.3	19.9
60	0.789	9	10.6	4.7	24.3
70	0.921	9	14.2	6.4	29.6
80	1.053	9	18.1	8.4	35.5

Procedure:

a. Select 5 flow rates above and below the network discharge rate of 60 gpm.

b. Calculate the orifice (perforation) flow rate for each of the flows. This is done by dividing the flow rate by the number of orifices in the network. For the 30 gpm and 76 orifices, the orifice flow rate is 0.395 gpm.

c. The elevation head is the height that the effluent is lifted.

d. The force main head is the head loss in the force main for the given flow rate. Table A-2 gives the friction loss. Need to select a force main diameter. For this example use 2" force main. For the 60 gpm the friction loss is 7.0 ft x 1.52 for head of 10.6 ft.

e. The network head is calculated by $H = 1.3(Q/(11.79d^2))^2$. H is head in ft, Q is orifice flow rate in gpm, and d is orifice diameter in inches. The 1.3 is an adjustment factor for friction loss in laterals. For 3/16" diameter orifice the equation is $H = 1.3(Q/0.4145)^2$.

f. The total head is the sum of the elevation, force main and network heads.

2. Determine the force main diameter.

Force main diameter:

Option A: = 2" (determined in Step 1 of Section B).

Option B: = 3"

3. Select the pressurization unit.

Plot the performance curves of several effluent pumps and the system performance curve (Fig. A-8). For the system curve plot the flow rates vs. he total head. On the system curve, using an X where the flow rate intersects the curve (in this case 60 gpm). Select the pump, represented by the pump performance curve, located next along the system performance curve just after 60 gpm (Pump B) as that is where the pump will operate. Pump C could be selected but it is over sized for the unit.

4. Determine the dose volume.

More recent thinking is that the dose volume should be reduced from the larger doses recommended earlier.

Use 5 times the lateral void volume. Use void volume from Table A-4.

	Option 1:	**Option 2:**
Lateral diameter =	1.5"	2.0"
Lateral Length =	56'	56'
No. of laterals =	4	2
Void volume =	0.092 gal/ft	0.163

Net dose volume

Option 1: = 5 x 56 x 4 x 0.092 = 103 gal./dose

Option 2: = 5 x 56 x 2 x 0.163 = 91.3 gal/dose

Flow back from force main

Option A: 2" force main @ 125 ft @ 0.163 gal./ft = 20.4 gal/dose

Option B: 3" force main@ 125 ft@ 0.0.367 gal/ft = 45.9 gal/dose

Set the floats to dose the combination selected:

Dose volume with Option 1 and Option A = 103 + 20 = 123 gpdose
Dose volume with Option 1 and Option B = 103 + 46 = 146
Dose volume with Option 2 and Option A = 91 + 20 = 111
Dose volume with Option 2 and Option B = 91 + 46 = 137

The net dose volume to the mound will be 91 or 103 gpd with either 20 or 46 gallons flowing back into pump chamber. No check valve is used to prevent flow back in cold climates due to freezing potential. If the dose is limited to 20% of the design flow, Option 1 with net dose of 91.3 is very close to 90 gpdose (450 gpd x 20%). Option 2 does not meet the 20% criteria.

5. Size the dose chamber.

Based on the dose volume, storage volume and room for a block beneath the pump and control space, 500 to 750 gallon chamber will suffice. If timed dosing is implemented, then a larger tank will be required to provide surge storage. Use 2/3 daily design flow for surge capacity.

6. **Select controls and alarm.**

   Demand Dosing: Controls include on-off float and alarm float. An event recorder and running time meter would be appropriate to install. If the pump is calibrated and dose depth recorded, these two counters can be used to monitor flow to the soil unit.

   Time Dosing: The advantage of time dosing provides more frequent doses and levels out peak flows to the soil treatment/dispersal unit. In mounds with longer laterals and larger orifices, compared to shorter laterals and smaller orifices in sand filters, time dosing may not be as appropriate as it is in sand filters.

7. **Select Effluent Filters.**

   Filters must be installed on the septic tank to minimize solids carry-over to the pump chamber. A second filter, located on the pump outlet, will keep any solids falling into the pump chamber from being carried over. Converse (1999) provides information relative to filters.

CONSTRUCTION AND MAINTENANCE

Good common sense should prevail when constructing and maintaining these systems. Good quality components should be used. There is no lack of good components today. Water tight construction practices must be employed for all tanks. Surface runoff must be diverted away from the system. Any settling around the tanks must be filled with the soil brought to grade or slightly above to divert surface waters. Provisions must be incorporated into the lateral design, such as turn-ups, to provide for easy flushing of the laterals as solids will build up and clog the orifices. **DO NOT ENTER THE TANKS WITHOUT PROPER SAFETY EQUIPMENT**.

References:

Converse, J.C. 1974 Distribution of domestic waste effluent in soil absorption beds. Trans. of the ASAE. 17:299-304.

Converse, J. C. 1999. Septic tanks and pump chambers with emphasis on filters, risers, pumps surge capacity and time dosing. Small Scale Waste Management Project. 345 King Hall, University of Wisconsin-Madison, 1525 Linden Drive, Madison, WI 53706.

Converse, J.C. and E.J. Tyler. 2000. Wisconsin Mound Soil Absorption Systems, Siting, Design and Construction. Small Scale Waste Management Project. 345 King Hall, University of Wisconsin-Madison, 1525 Linden Drive, Madison, WI 53706. Publication No. 15.22.

Falkowski, G.M. and J.C. Converse. 1998. Siphon performance and pressure distribution for on-site systems. In. On-site Wastewater Treatment. Proceedings of the Fifth National Symposium on Individual and Small Community Sewage Systems. ASAE. Joseph, MI 49085.

Machmeier, R.E. and J.L Anderson. 1988. Flow distribution by gravity flow in perforated pipe. In. On-site Wastewater Treatment. Proceedings of the Fifth National Symposium on Individual and Small Community Sewage Systems. ASE. Joseph, MI 49085.

Otis, R.J. 1981. Design of pressure distribution networks for septic tank- soil absorption systems. Small Scale Waste Management Project. 345 King Hall, University of Wisconsin-Madison, 1525 Linden Drive, Madison, WI 53706. Publication No. 9.6.

Sump and Sewage Pump Manufacturers Association. 1998. Recommended guidelines for sizing effluent pumps. P.O. Box 647 Northbrook, Il 600065-0647.

Wisconsin Administrative Code. 1999. Pressure distribution component manual for private onsite wastewater treatment systems. Department of Commerce, Safety and Building Division, Madison, WI.

Table A-1. Discharge rates from orifices.

	Orifice diameter (in.)				
Pressure	1/8	3/16	1/4	5/16	3/8
(ft)	(gpm)				
2.5	0.29	0.66	1.17	1.82	2.62
3.0	0.32	0.72	1.28	1.00	2.87
3.5	0.34	0.78	1.38	2.15	3.10
4.0	0.37	0.83	1.47	2.30	3.32
4.5	0.39	0.88	1.56	2.44	3.52
5.0	0.41	0.93	1.65	2.57	3.71
5.5	0.43	0.97	1.73	2.70	3.89
6.0	0.45	1.02	1.80	2.82	4.06
6.5	0.47	1.06	1.88	2.94	4.23
7.0	0.49	1.10	1.95	3.05	4.39
7.5	0.50	1.14	2.02	3.15	4.54
8.0	0.52	1.17	2.08	3.26	4.69
8.5	0.54	1.21	2.15	3.36	4.83
9.0	0.55	1.24	2.21	3.45	4.97
9.5	0.57	1.28	2.27	3.55	5.11
10.0	0.58	1.31	2.33	3.64	5.24

Values were calculated as: gpm = $11.79 \times d^2 \times h^{1/2}$ where d = orifice dia. in inches, h = head feet.

Table A-2. Friction loss in plastic pipe.

Flow	Nominal Pipe Size						
(gpm)	3/4	1	1-1/4	1-1/2	2	3	4
				(Feet/100 ft of pipe)			
2							
3	3.24						
4	5.52						
5	8.34						
6	11.68	2.88		Velocities in this area are below 2 fps.			
7	15.53	3.83					
8	19.89	4.91					
9	24.73	6.10					
10	30.05	7.41	2.50				
11	35.84	8.84	2.99				
12	42.10	10.39	3.51				
13	48.82	12.04	4.07				
14	56.00	13.81	4.66	1.92			
15	63.63	15.69	5.30	2.18			
16	71.69	17.68	5.97	2.46			
17	80.20	19.78	6.68	2.75			
18		21.99	7.42	3.06			
19		24.30	8.21	3.38			
20		26.72	9.02	3.72			
25		40.38	13.63	5.62	1.39		
30		56.57	19.10	7.87	1.94		
35			25.41	10.46	2.58		
40			32.53	13.40	3.30		
45			40.45	16.66	4.11		
50			49.15	20.24	4.99		
60				28.36	7.00	0.97	
70				37.72	9.31	1.29	
80	Velocities in theses areas				11.91	1.66	
90	exceed 10 fps, which is too great				14.81	2.06	
100	for various flows and pipe diameters				18.00	2.50	0.62
125					27.20	3.78	0.93
150						5.30	1.31
175						7.05	1.74

Note: Table is based on - Hazen-Williams formula: $h = 0.002082L \times (100/C)^{1.85} \times (gpm^{1.85}/d^{4.8655})$ where: h = feet of head, L = length in feet, C= Friction factor from Hazen-Williams (145 for plastic pipe), gpm = gallons per minute, d= nominal pipe size.

Table A-3. Friction losses through plastic fittings in terms of equivalent lengths of pipe. (Sump and Sewage Pump Manufacturers, 1998)

	Nominal size fitting and pipe					
Type of Fitting	1-1/4	1-1/2	2	2-1/2	3	4
90° STD Elbow	7.0	8.0	9.0	10.0	12.0	14.0
45° Elbow	3.0	3.0	4.0	4.0	6.0	8.0
STD. Tee (Diversion)	7.0	9.0	11.0	14.0	17.0	22.0
Check Valve	11.0	13.0	17.0	21.0	26.0	33.0
Coupling/ Quick Disconnect	1.0	1.0	2.0	3.0	4.0	5.0
Gate Valve	0.9	1.1	1.4	1.7	2.0	2.3

Table A-4. Void volume for various diameter pipes.

Nominal Pipe Size (In.)	Void Volume (gal./ft)
3/4	0.023
1	0.041
1-1/4	0.064
1-1/2	0.092
2	0.163
3	0.367
4	0.650
6	1.469

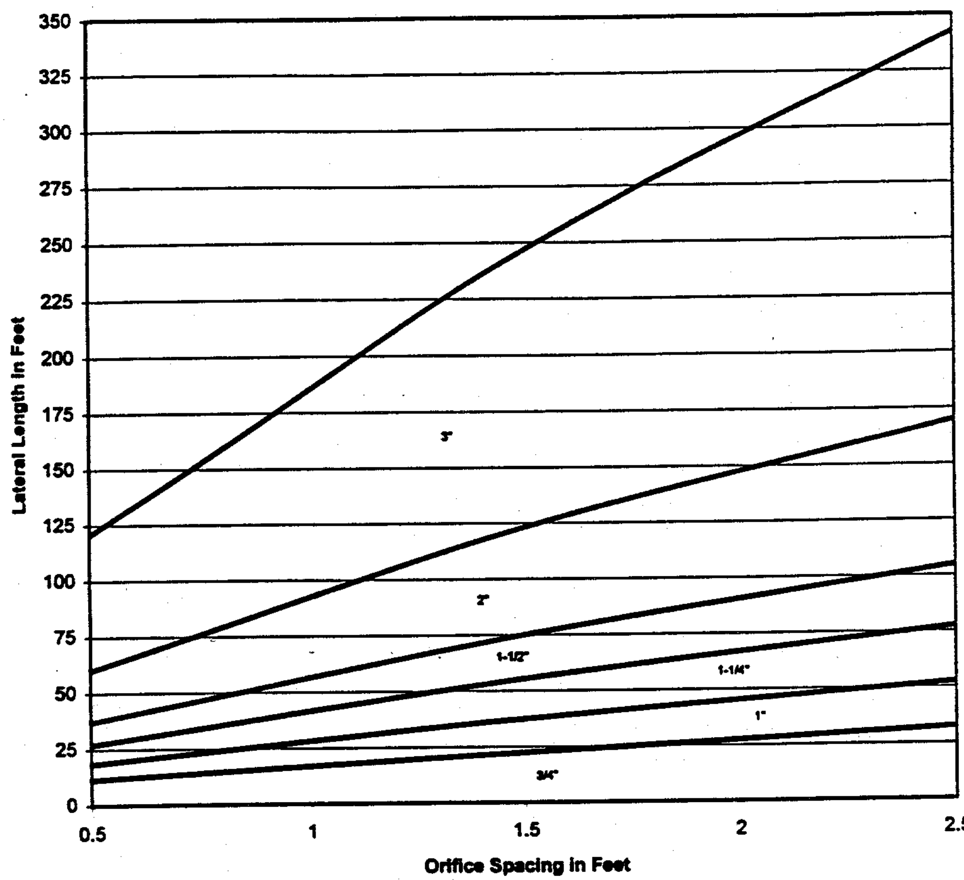


Fig. A -1a. Minimum lateral diameter based on orifice spacing for 1/8 in. diameter orifices (Wisc. Dept. Of Commerce, 1999b).

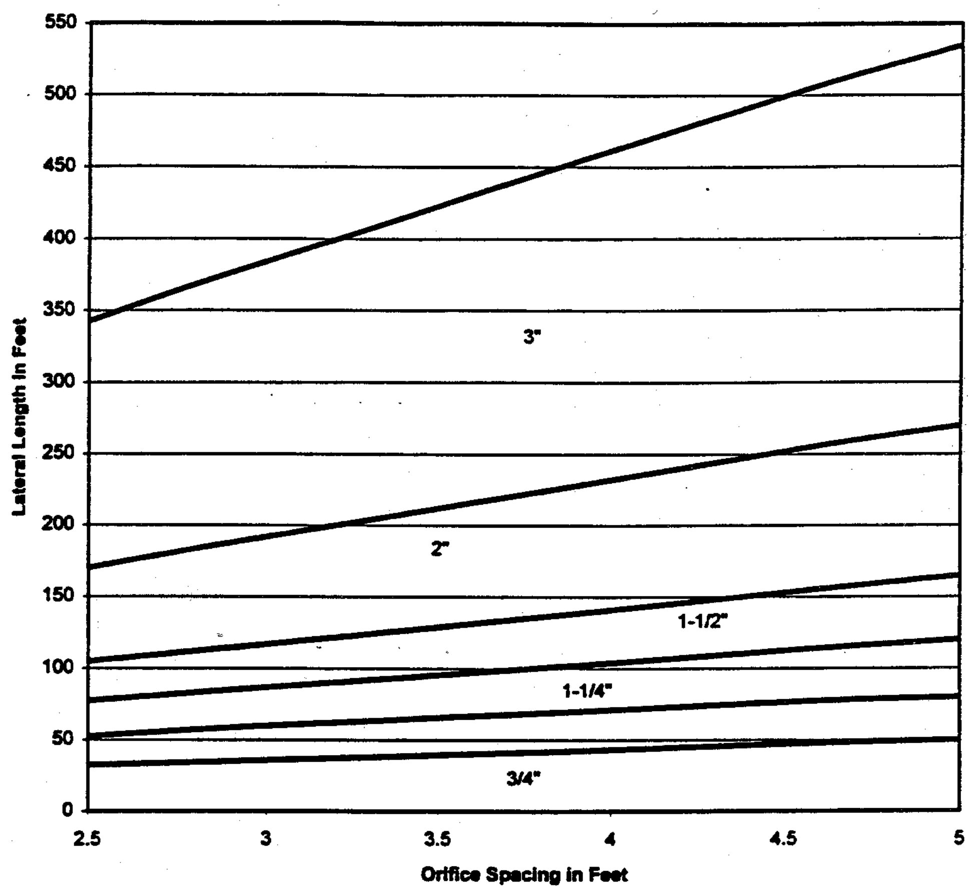


Fig. A -1b. Minimum lateral diameter based on orifice spacing for 1/8 in. diameter orifices (Wisc. Dept. Of Commerce, 1999b).

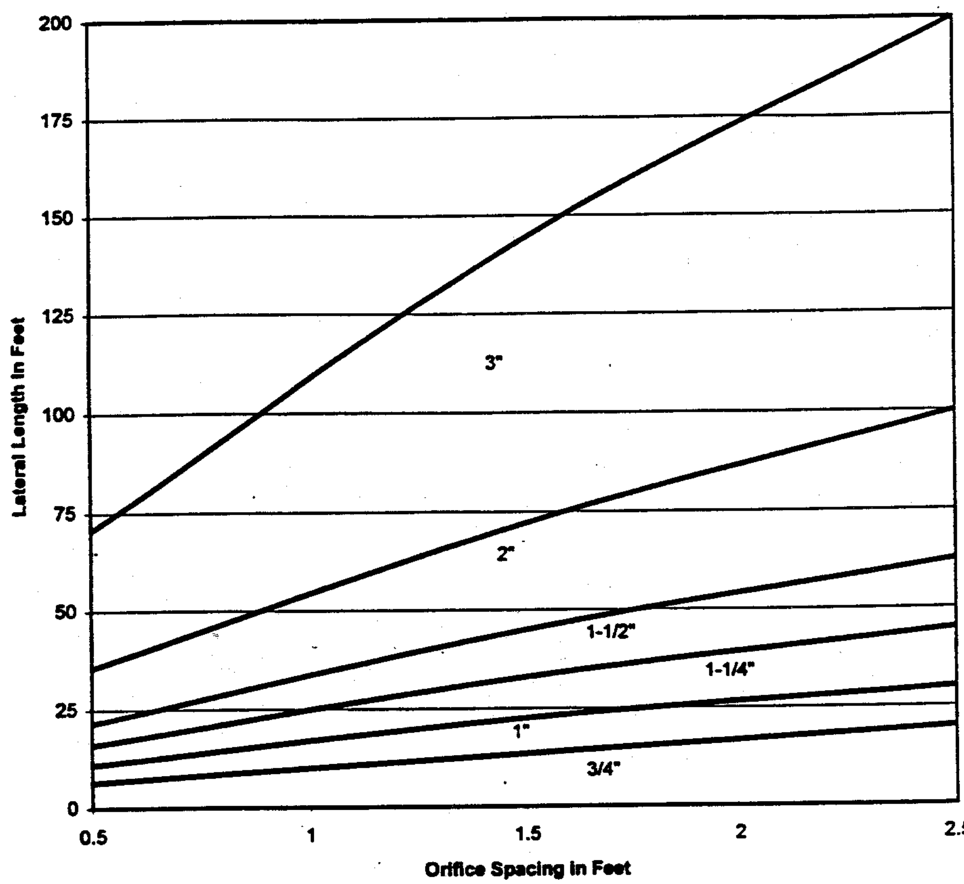


Fig. A -2a. Minimum lateral diameter based on orifice spacing for 3/16 in. diameter orifices (Wisc. Dept. Of Commerce, 1999b).

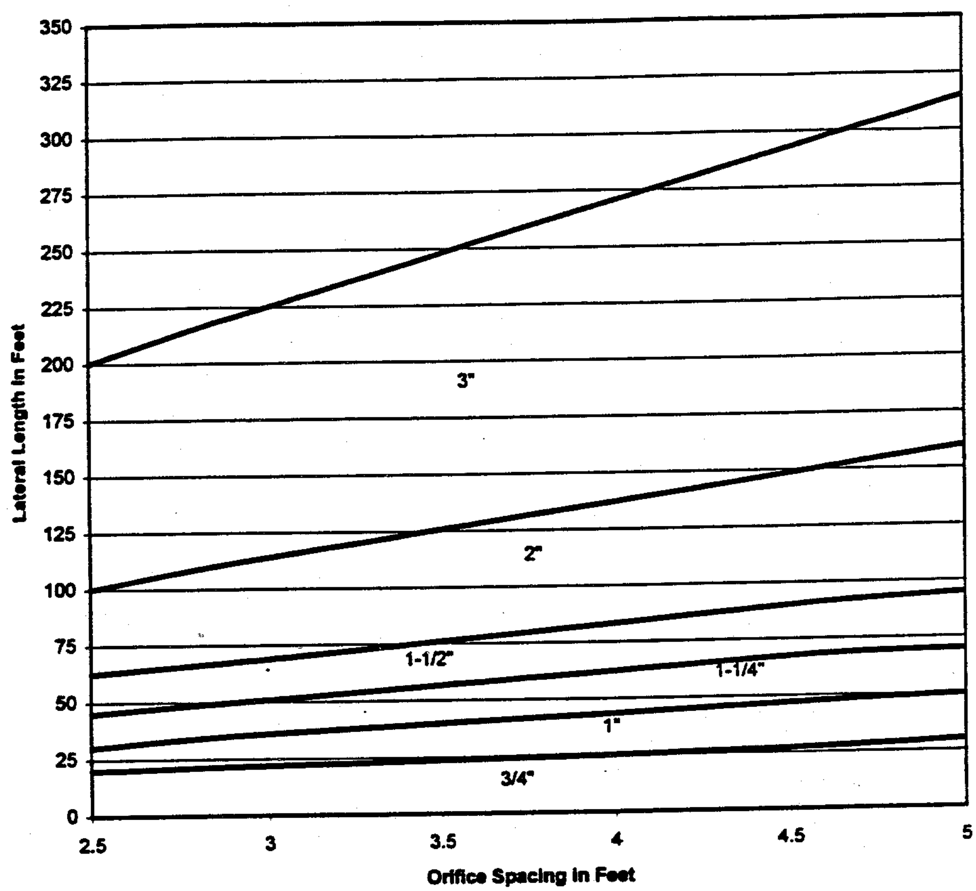


Fig. A -2b. Minimum lateral diameter based on orifice spacing for 3/16 in. diameter orifices (Wisc. Dept. Of Commerce, 1999b).

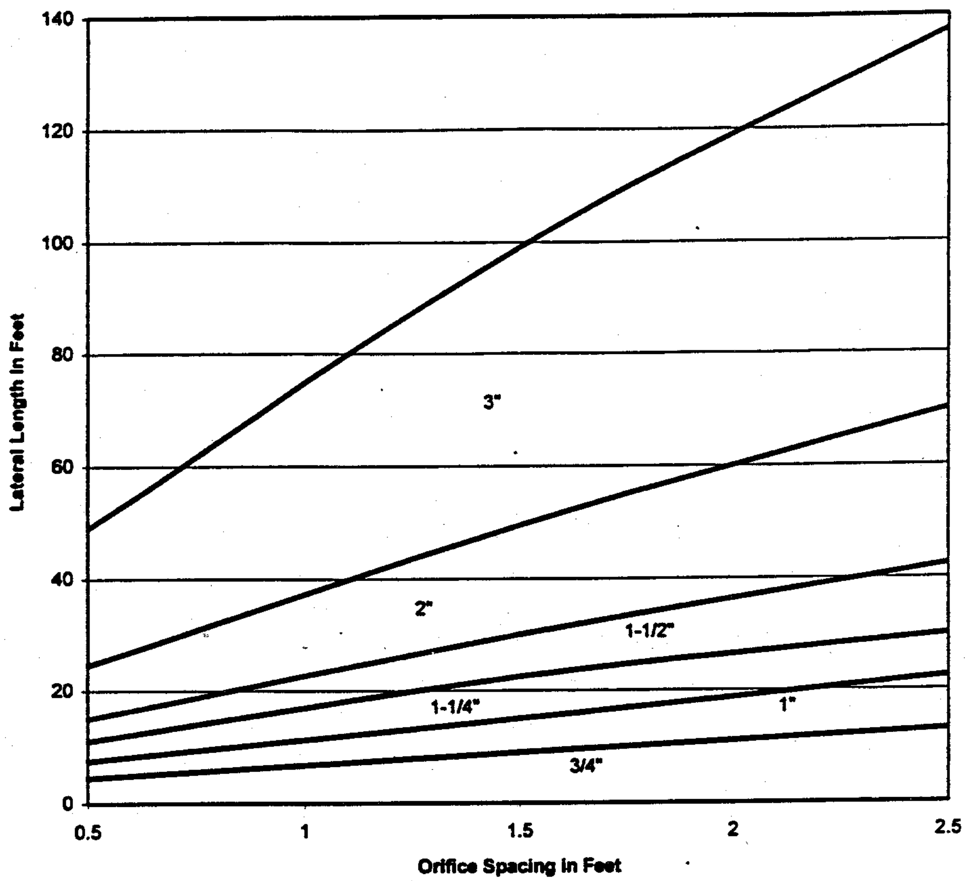


Fig. A -3a. Minimum lateral diameter based on orifice spacing for 1/4 in. diameter orifices (Wisc. Dept. Of Commerce, 1999b).

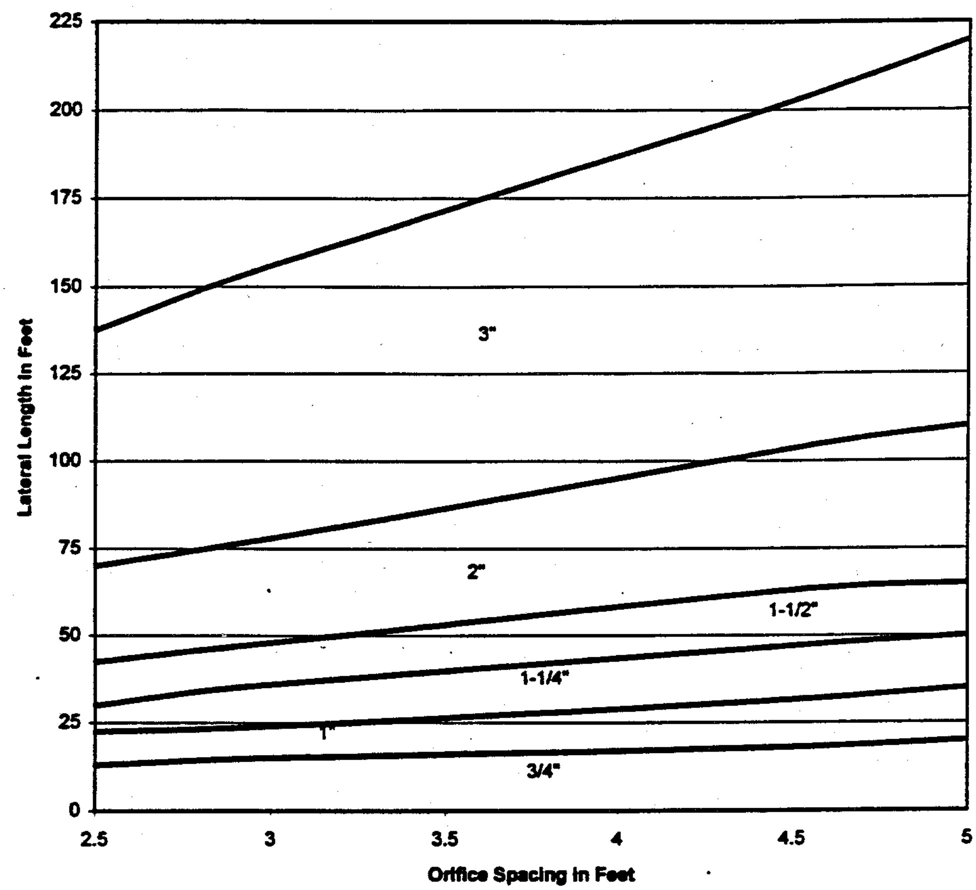


Fig. A -3b. Minimum lateral diameter based on orifice spacing for 1/4 in. diameter orifices (Wisc. Dept. Of Commerce, 1999b).

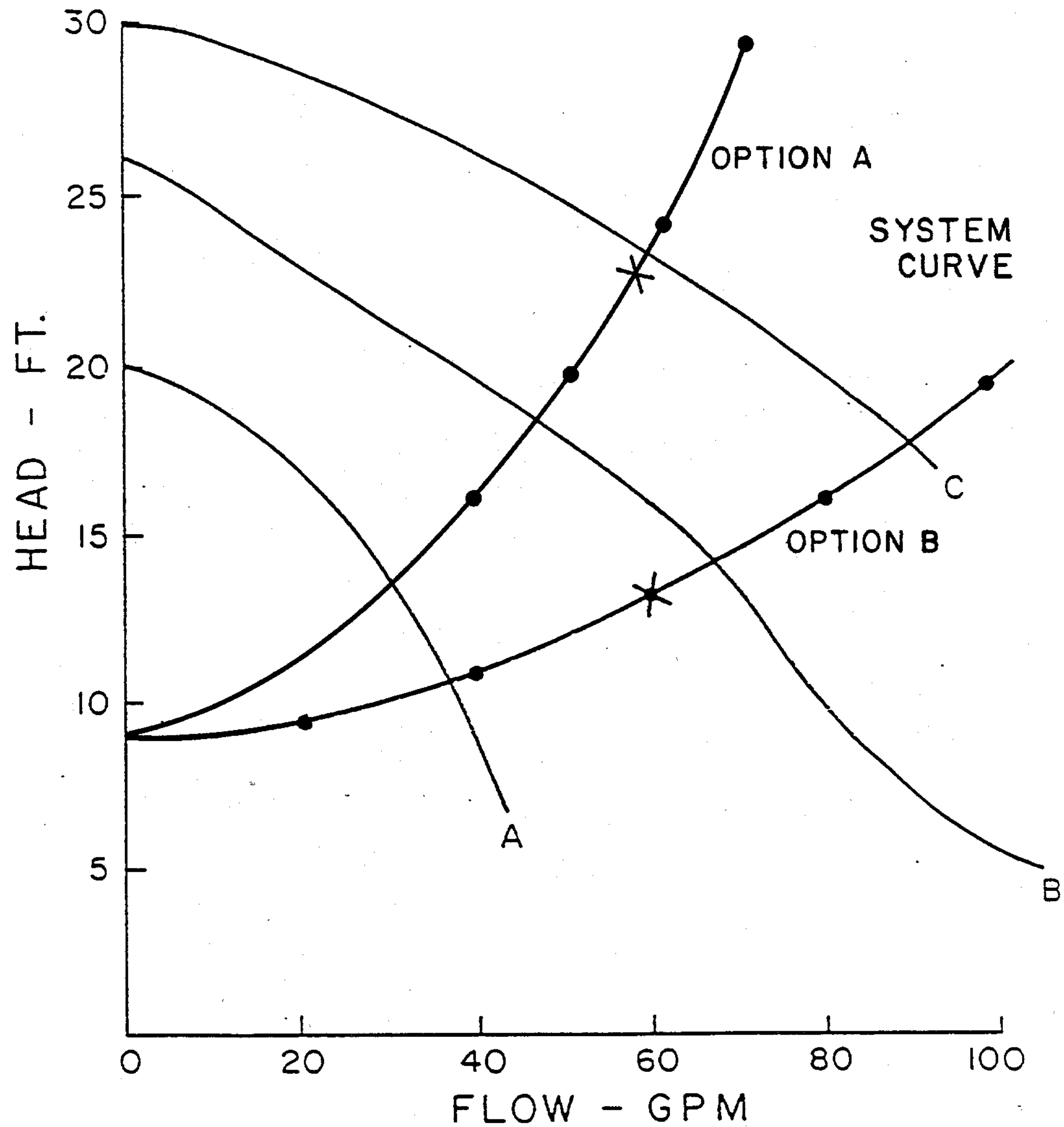


Fig. A-4 System performance curve and several pump performance curves for the example problem. For this example, the pump must provide a flow of at least 60 gpm (represented by X on the system performance curve. Pump A, represented by performance curve A, will not provide it. Pump C exceeds the requuirmements considerably and the curves interesect near the end of the pump curve. Pump B is the correct pump to select as it is just slighly above the desired point (X) and it is toard the middle of the pump curve.

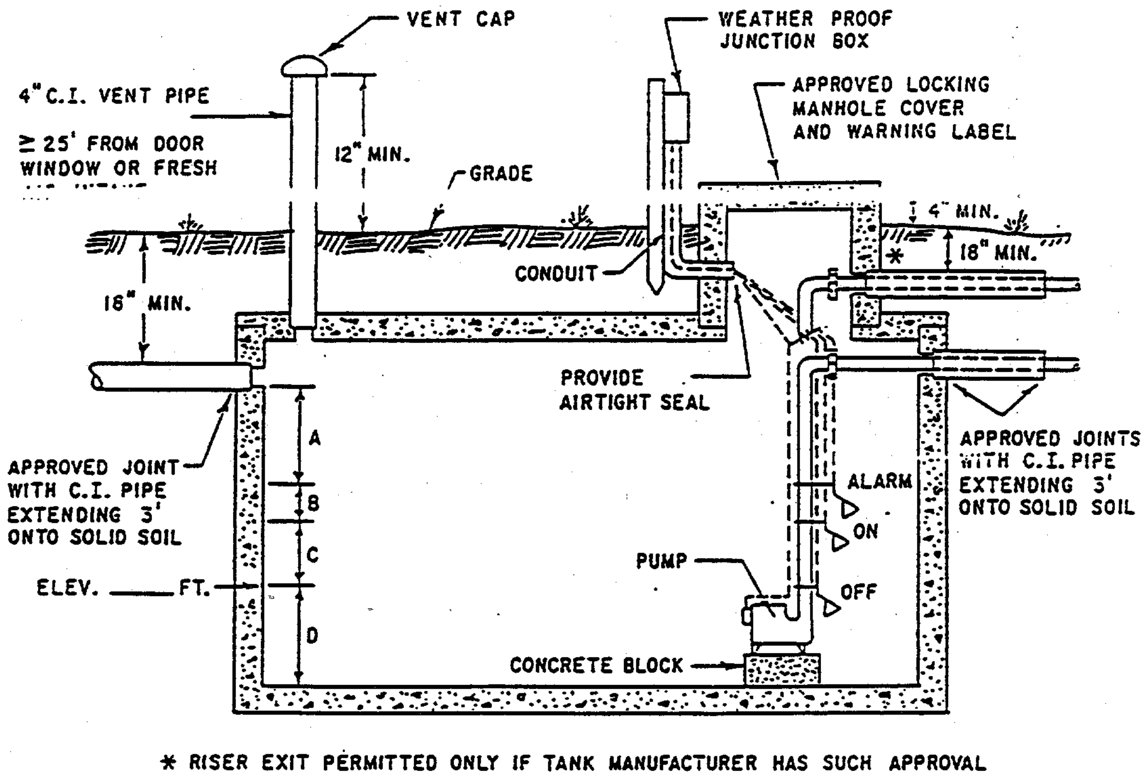


Fig. A-5. Cross section of a dose chamber with pump and floats. There are other examples available. Make sure it meets code.

Part III: Dosing Siphons

Another method of pressurizing the distribution system is by using a dosing siphon. The following paper by Eric S. Ball, P.E., discusses the design, use, and installation of dosing siphons.

Design, Use and Installation of Dosing Siphons for On-site Wastewater Treatment Systems

Eric S. Ball, P.E.
Orenco Systems, Inc.
814 Airway Avenue
Sutherlin, Oregon 97479

Introduction

Automatic dosing siphons are nothing new. They've been used for 100 years or more to flush livestock yards, in sewage treatment plants to dose trickling filters, and to dose recirculating sand filters. What is new is that as increases in suburban and rural populations have spurred development of innovative and alternative wastewater management methods, dosing siphons have become commonplace in single family and small community systems where they are used to dose gravity and pressurized drainfields as well as sand filters.

Dosing siphons are useful devices for dosing fixed, finite volumes of liquid at flow rates ranging from a few gallons per minute to several hundred gallons per minute. In on-site wastewater systems, siphons are especially useful in converting small, continuous flows into large intermittent dosing flows. Modern siphons are made of corrosion resistant materials, have no moving parts, require no power source, are easy to install, and require very little maintenance. They are a cost-effective alternative to pumps in many situations, especially in remote areas and other sites where electricity is difficult to obtain.

One criterion must be met in any siphon system: the area to be dosed must be downhill from the dosing tank. A siphon will discharge only to a lower elevation.

Basic Siphon Operation

Nomenclature

An automatic dosing siphon has two main components—the bell and the trap (Figure 1). The bell includes the bell housing itself, a vertical inlet pipe, an intrusion pipe, and a snifter pipe. The trap includes a long leg, a short leg, and a discharge fitting with an air vent. Depending on the siphon drawdown, the trap may be outfitted with an external trigger trap. The bell and trap are connected with threaded fittings.

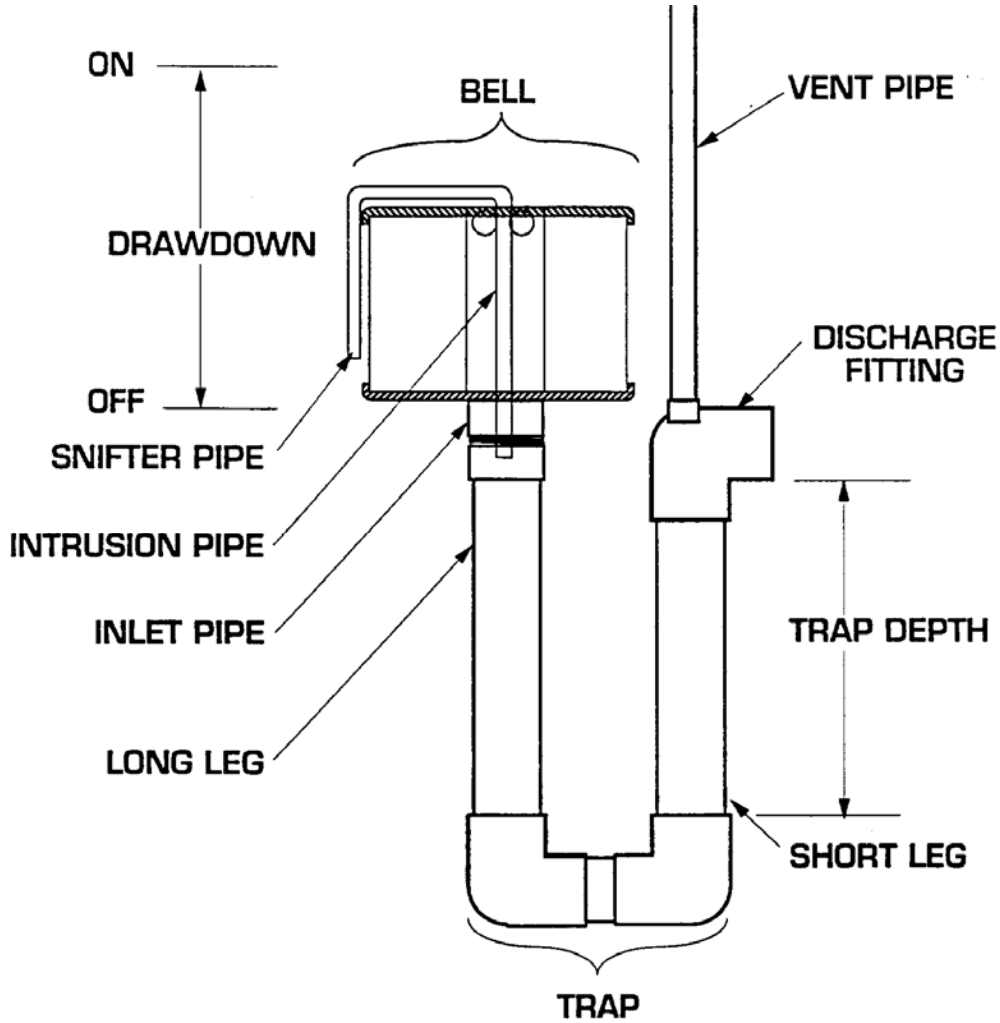
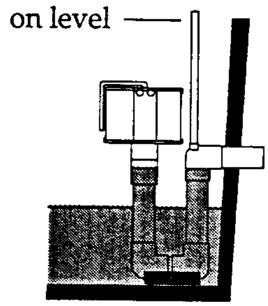


Figure 1: Siphon Nomenclature

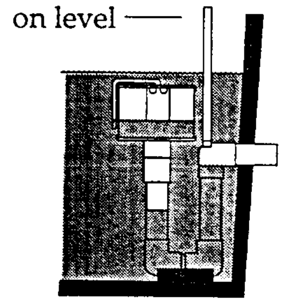
Single Siphon Operation

Following installation in a tank, a siphon must have its trap(s) filled with water. When fluid rises above the open end of the snifter pipe, air is sealed in the bell and long leg of the siphon. As the fluid in the tank rises further, the pressure on the confined air increases and forces water out of the long leg of the trap. Once the pressure is great enough to force all the water out of the long leg, the trapped air escapes through the short leg to the air release vent pipe. At this point, the siphon has been "tripped" and fluid is discharged from the siphon until the liquid level in tank drops to the bottom of the bell. Air is then drawn under the bell which "breaks" the siphoning action and the process begins again. Figure 2 shows one complete cycle of a single siphon. At the end of a dosing cycle, incoming flow may seal off the bottom of the bell before the bell is fully recharged with air. The snifter pipe, with its open end an inch or more above the bottom of the bell, allows a full recharge of air beneath the bell at the end of each cycle. Because the end of the snifter pipe is the elevation at which air becomes trapped under the bell, shortening or lengthening the snifter pipe is an effective way to increase or decrease the "on"

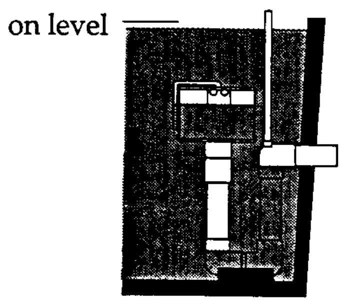
or "trip" level of the siphon. There are limits, however, to the amount of adjustment allowable. Installers should consult the siphon manufacturer before altering the length of the snifter pipe.



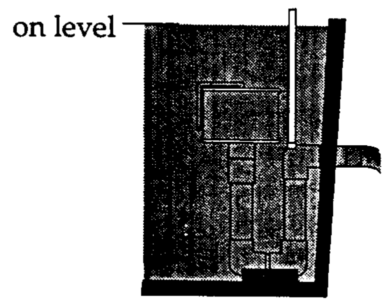
2a. Trap must be primed (filled with water) prior to raising liquid level above bottom of snifter pipe.



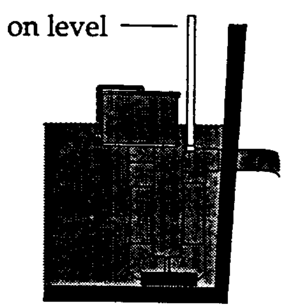
2b. Water is discharged from long leg as water level rises above snifter pipe.



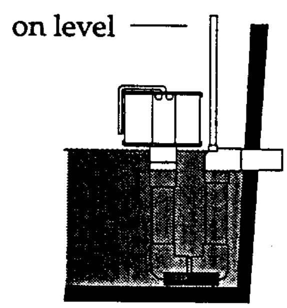
2c. Just before triggering, water level in long leg is near bottom of trap.



2d. Siphon is triggered when air is vented through vent pipe.



2e. Siphon continues to dose until water level drops to bottom of bell.



2f. Air under bell "breaks" the siphon. Snifter pipe ensures full recharge of air under bell.

Figure 2

Some siphons require an additional mechanism called a trigger trap to exhaust all of the air from under the bell at the beginning of the cycle. Whether or not a siphon requires a trigger trap depends on several variables: bell diameter, bell height, trap diameter, and the height over the bell at which the siphon activates. For a given bell configuration, it is determined mathematically and experimentally whether a trigger trap is necessary. The trigger trap actually starts the siphon cycle.

Siphons needing trigger traps typically have relatively short drawdowns as compared to the siphon diameter and thus have lower available driving head to exhaust air. Without a trigger trap, the full volume of trapped air fails to exhaust and the siphon goes into what is called a drooling, or trickling mode. In this mode—with some air still trapped under the bell—the water level has risen inside the bell above the intake of the inlet pipe and liquid is exiting the siphon at a fraction of the full siphon discharge rate. Absent a true siphoning effect, the water level in the tank will not drop below the level of the inlet pipe's intake. Since this intake is above the bottom of the snifter pipe, the siphon cannot be recharged with air and will continue to operate indefinitely in a trickling mode.

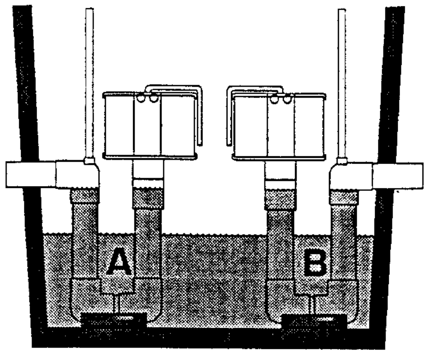
It is possible to force a siphon that should have a trigger trap (but doesn't) into seemingly working properly by filling the tank very quickly. This rapid filling provides extra driving head to force all the air out of the bell. However, most tanks with an installed siphon fill much slower than this rapid rate. A recent study has shown poorly designed siphons (needing trigger traps) to be a primary cause of failures in the field. Coincidentally, the same circumstance—filling the tank too rapidly at the end of a dosing cycle—can also cause a properly designed siphon to go into a trickling mode. In this case, water is entering the tank so fast that the snifter pipe is sealed before the bell is fully recharged with air.

Alternating Siphons

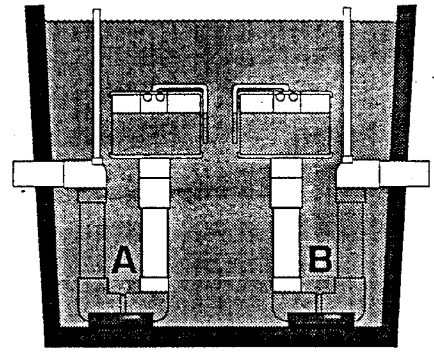
Two identical siphons, installed in a single chamber at the same elevation (Figure 3), will alternate automatically. Because of slight variations in dimension and/or slight variations in the elevation of the two bells, one of the two siphons will trigger first. The siphon that triggered first will end the first dosing cycle with its trap full. The siphon that didn't trigger will have lost much of the water in its trap at the end of the first dosing cycle. When the tank fills up a second time, the second siphon will trip first since its trap is only partially full and requires less pressure to trip. The third time the tank fills up, the first siphon, with its trap only partially full, will trip first. This alternating process will repeat itself indefinitely. In Figure 3, the on level of the first cycle will be a distance H' above the bell. All subsequent cycles will operate at height H, since all cycles after the first are triggered from a partially full trap. For most siphons, H is approximately one inch lower than H'.

Multiple Sequencing Siphons

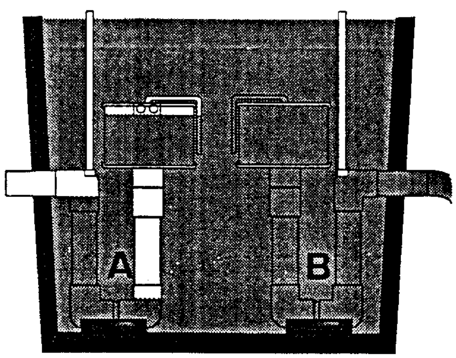
Near the turn of the century, several methods were designed to alternate three, four, or more siphons to dose sewage. These include various types of sequencing starting bells and other mechanical devices. Now, electrical or air operated solenoid valves are also used. However, troubleshooting and maintenance of multiple sequencing siphon systems can be difficult. There are simpler, more reliable ways to design systems that avoid multiple sequencing siphons. These include flow splitting devices prior to any number of single or alternating dosing siphons.



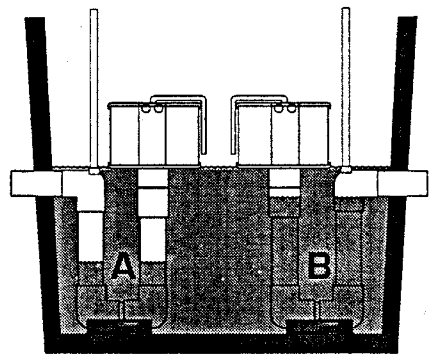
3a. Alternating siphons with traps primed prior to first cycle.



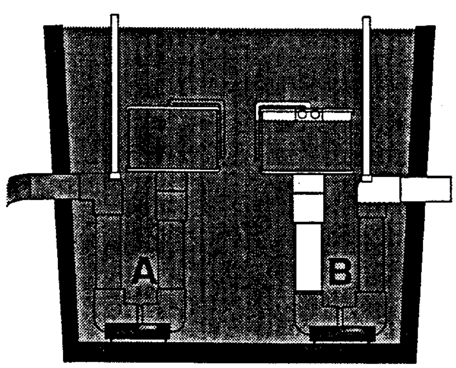
3b. Water is discharged out of the long leg of both siphons as the water level rises in the tank above the snifter pipe.



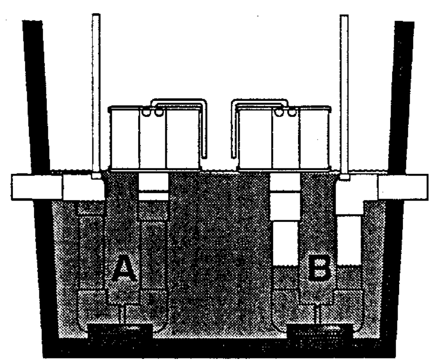
3c. Because of slight variations in the two siphons, one (siphon B in this example) triggers before the other.



3d. End of first cycle - siphon that didn't trigger (A) has partially full trap.



3e. Siphon A, needing less pressure on its partially full trap, triggers the second cycle.



3f. End of second cycle - siphon B now has partially full trap and will trigger next.

Figure 3

Siphon Sizes

The size of a siphon refers to the diameter of its trap. Siphons are most commonly

available in diameters from two inches to eight inches. Common drawdowns may range from four to 48 inches. Most manufacturers use three digit model numbers. The first digit refers to the siphon's diameter and the last two digits indicate the drawdown. A model 324, for example, designates a three inch diameter siphon with a 24 inch drawdown. Custom siphons can be built with virtually any diameter and drawdown.

Siphon discharge flow rates are normally given in gallons per minute (gpm) in one or all of the following forms: maximum flow rate, minimum flow rate, and average flow rate. These flow rates are measured at open discharge and thus do not include transport pipe friction losses or head losses due to trapped air. As discussed later, pressurized systems are usually designed using a flow rate somewhat below the average flow rate of the siphon.

Installation Configurations

Siphons can be installed in virtually any type of tank, basin, or reservoir that holds a fluid. In wastewater systems, siphons are installed most often in concrete or fiberglass dosing septic tanks ranging in size from 500 to several thousand gallons. They also may be installed in smaller basins ranging in size from about 50 gallons to a few hundred gallons. Basins are commonly constructed of concrete, fiberglass, PVC, or polyethylene.

For small flow rate systems (30 gpm or less), the most cost-effective installation is a two inch siphon mounted in a screened vault which is placed directly in a single compartment septic tank (Figure 4), so that a second dosing tank or chamber is not required. Two inch vault-mounted siphons may also be installed in compartmented septic tanks or separate dosing tanks. This type of siphon suspends from the top of the tank and is easily removed for cleaning and maintenance of both the

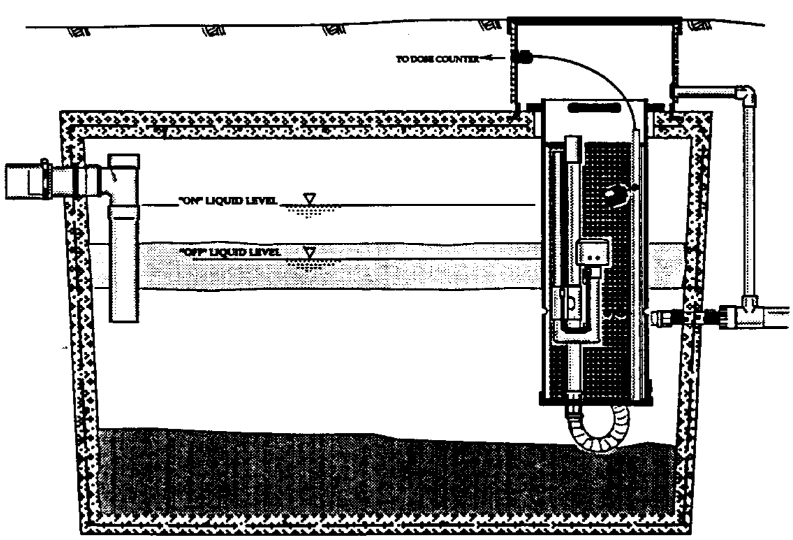


Figure 4: Single Compartment Dosing Tank

siphon and the tank.

Systems that are designed for flow rates greater than 30 gpm require a three inch or larger siphon installed in a compartmented septic tank or separate dosing tank (Figures 5 & 6). Three inch and larger siphons are located in the tank with the bottom of the trap positioned in one of three places: above the bottom, on the bottom, or through the bottom of the tank (Figures 6,7, & 8). Placement depends on the dimensions of the tank and siphon and the desired trip level. The two most common methods of installation are bolt-in-place and cast-in-place. If the trap of the siphon does not need to extend beneath the bottom of the tank, either method may be used. A fiberglass bolt-in bracket is simplest, quickest, and most cost effective in this situation (Figures 5 & 6). If the trap of the siphon needs to extend below the bottom of the tank (Figure 7), the cast-in method must be used. Installations through the tank floor are more difficult and time consuming than other methods.

Filtering

Regardless of the type of siphon or method of installation, filtering the effluent before it reaches the siphon is required. A filter helps protect the performance of the siphon, the distribution network, and the disposal area. A key benefit of filtering is keeping the siphon's snifter pipe clear. If blockage, even momentary, of the

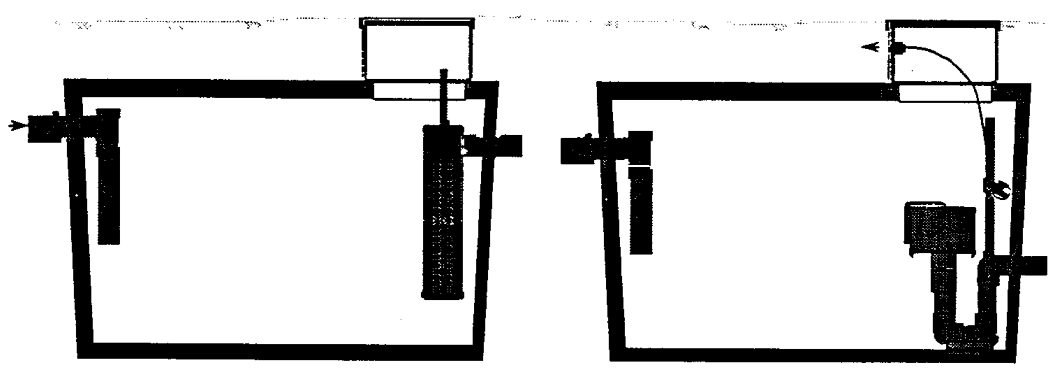


Figure 5: Bolt-In method of installation in a single compartment dosing tank

snifter pipe occurs during the end of the discharge cycle, the siphon may cease to operate and fail in a trickling mode. Momentary blockage may be caused by floating debris that subsequently floats away or disintegrates, with the result that the siphon ceases to function <u>for no apparent reason</u>. Three methods of filtering are used: a screened vault (two inch siphons only), an outlet filter installed in a tank or chamber prior to the siphon chamber (Figure 5), or a screen that surrounds the siphon itself (Figure 6). For siphons three inch and larger, the preferred method of

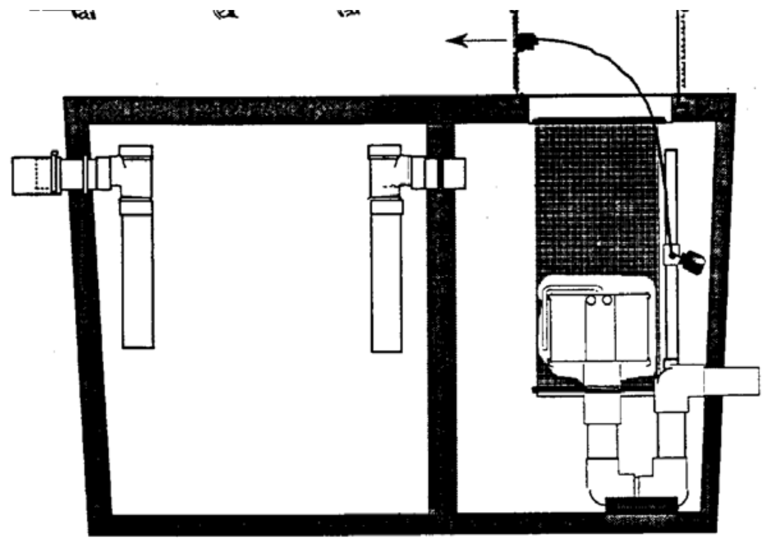


Figure 6: Bolt-In method of installation in a two compartment dosing tank

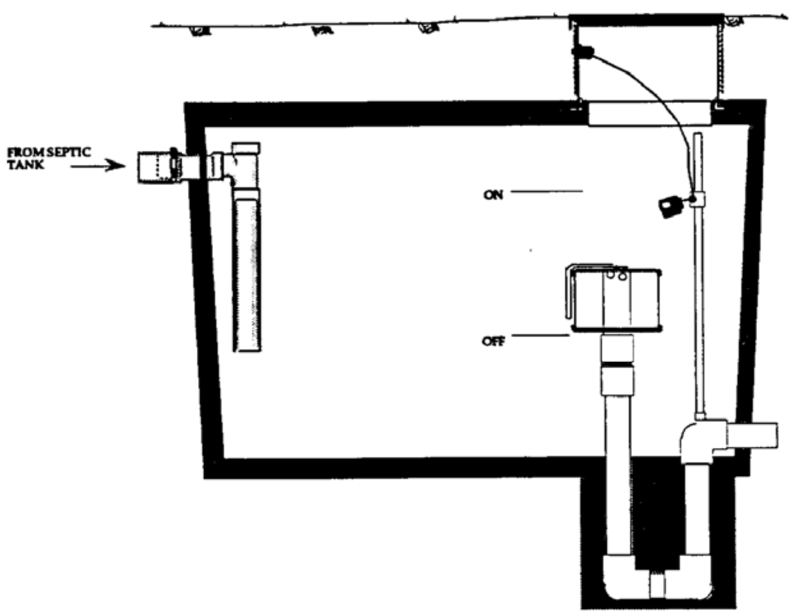


Figure 7: Cast-In method of installation (through tank floor)

filtering is the outlet filter.

Siphon Applications

In on-site treatment systems, siphons commonly discharge to gravity or pressurized drainfields. Distribution to gravity drainfields is done most effectively by directing the siphon discharge to a Hydrosplitter. Pressurized by the siphon, a Hydrosplitter distributes flow evenly to each individual trench. Flow can be split unevenly (with the use of flow control orifices in the Hydrosplitter) to accommodate differing trench lengths. A siphon can also discharge into common drop and distribution boxes. The flow rate of the siphon is usually not as critical when discharging to a gravity box as it is when discharging to a Hydrosplitter. On a system using a

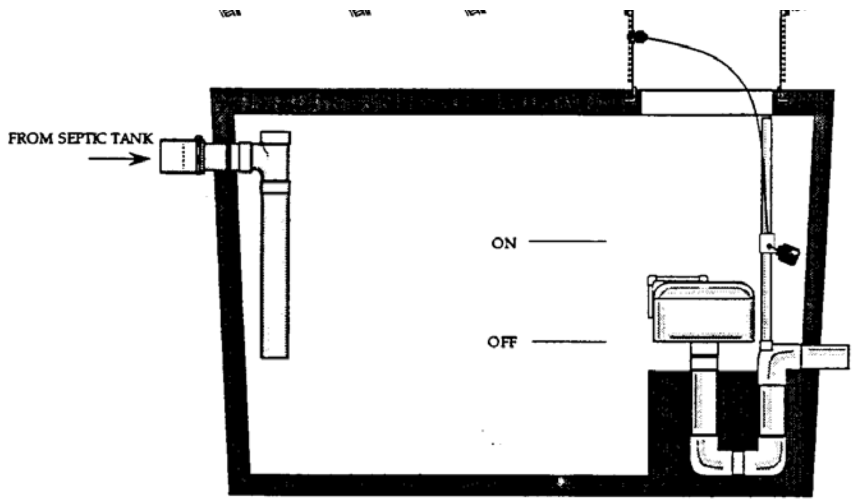


Figure 8: Cast-In method of installation (above tank floor)

Hydrosplitter, the flow rate of the siphon must be matched with the flow control orifices so that when the siphon discharges, the transport line will backfill to a height to provide pressure at the Hydrosplitter.

Sizing siphons for pressurized drainfields is similar to sizing those with Hydrosplitters in that the discharge rate of the siphon must be large enough to cause the transport line to backfill. The pressure at the orifices (squirt height) is created by the vertical elevation (static head) of the backfilled portion of the transport line as shown in Figure 9.

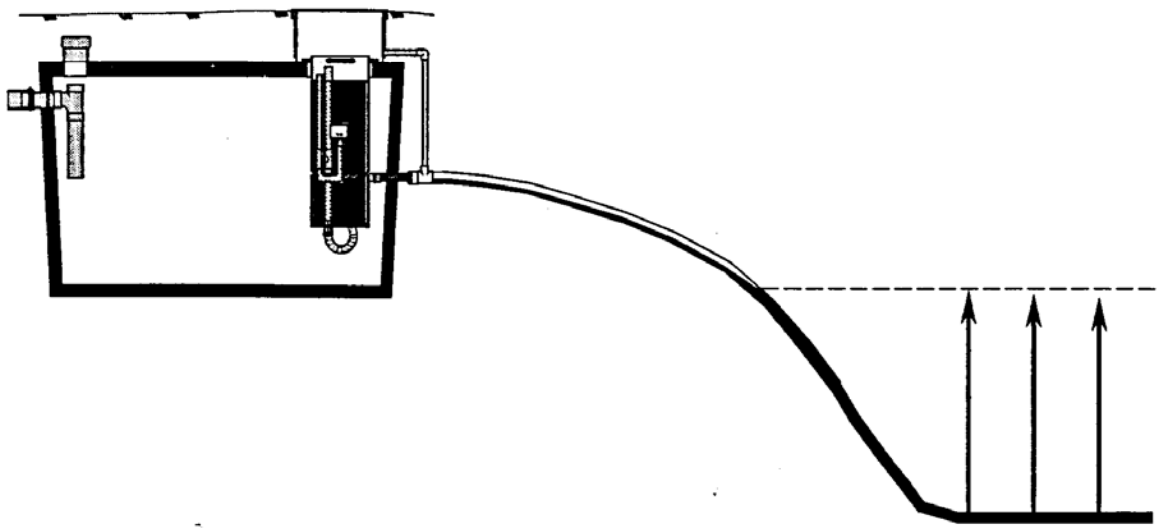


Figure 9: Squirt height relationship to transport line

Siphons are regularly used in septic tanks to dose intermittent sand filters. A two inch siphon may also be installed in a sand filter collection basin. If siphons are used for both functions, a complete sand filter system with pressure dosed drainfield can be installed with no power required. Of course, this is limited to a fairly

well sloped site since there must be fall from the septic tank to the top of the sand filter and from the bottom of the sand filter to the disposal field.

A siphon may be discharged to a flow splitter basin to divide large flows. Similar to Hydrosplitters, flow splitter basins are adapted to higher flow rates and are more versatile for field adjustments and maintenance. A siphon discharging to a flow splitter basin that feeds several tanks with alternating dosing siphons is a method that can be used to avoid multiple sequencing siphons for large disposal fields.

Effluent pumps may be used effectively in conjunction with dosing siphons. For example, a disposal field requires a high flow rate to pressurize it, but it's at a higher elevation than the dose tank. Instead of a large horsepower pump in the dose chamber, a small, easy to maintain effluent pump might be used to transport effluent to a second higher-elevation dosing tank containing a high flow-rate siphon. Pump/siphon combinations are also useful for disposal fields that are far from the collection point. A small effluent pump can be used to pump the effluent in a small diameter PVC line to a tank with a dosing siphon. This eliminates the need for large diameter transport lines capable of handling the dosing flow rate.

Siphon System Design

To gravity drainfields (without Hydrosplitters), the flow rate is usually not critical. Therefore, the following discussion refers mainly to pressurized systems. The details involved in achieving ideal transport line conditions, however, are applicable for all siphon and pump systems.

Accurate information on the topography of the site is essential for laying out a siphon system. The transport line length and profile are critical in determining how or if the system will operate. It is important to allow open channel flow along the length of the transport line so that the air that is displaced can vent to an air vent located at the start of the transport line. If open channel flow cannot be maintained, additional air venting will be necessary. Manning's equation can be used to determine if the slope is steep enough to maintain open channel flow. The designer must, however, be aware of the limitations of theoretical calculations.

The ideal transport line is one pipe diameter size larger than the siphon and is as short as possible with a constant slope from the outlet of the siphon to the disposal field (Figure 10). Unfortunately, many sites fall short of ideal. Long transport lines with changes in slope are often unavoidable. Nevertheless, steps can be taken to head off potential problems. The most common problem in transport lines is air binding caused by significant changes in slope (Figure 11). In the example shown in Figure 11, the problem is that the initial slope out of the siphon is less than the friction head loss of the pipe flowing full. Thus, the pipe may be flowing full at the change to a steeper slope and the air in the lower portion of transport line cannot

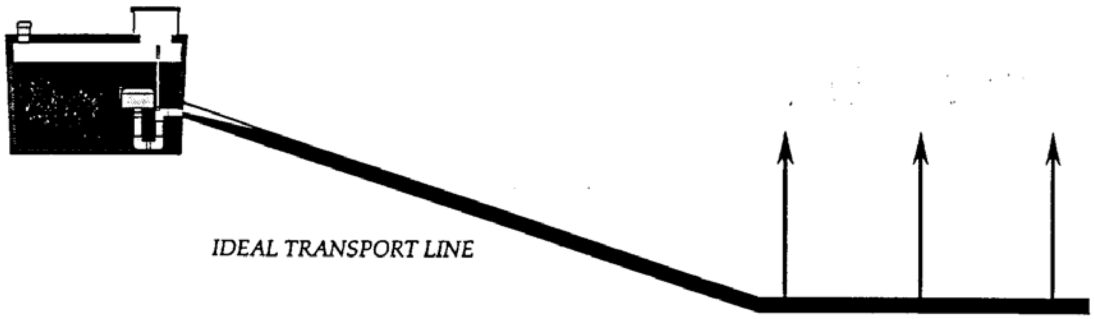


Figure 10: Transport line with constant slope

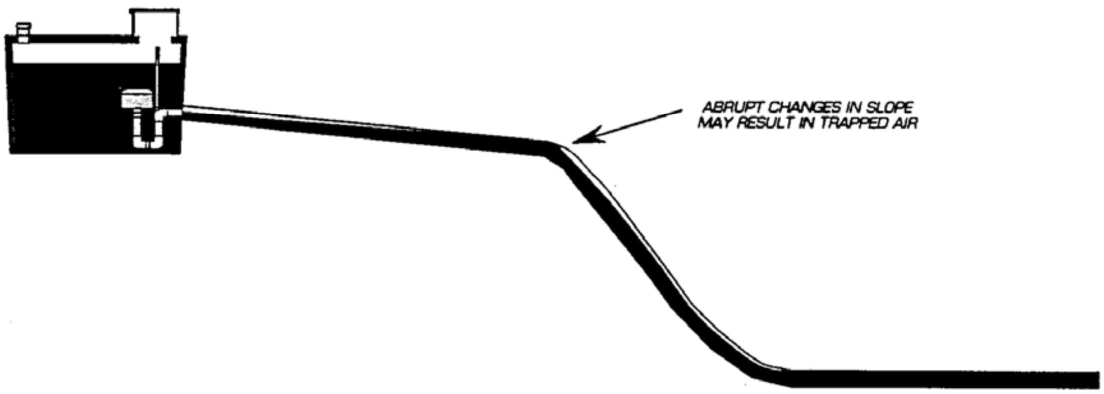


Figure 11: Transport line with significant change in slope

exit the air vent near the tank. Additionally, the flow just out of the siphon is unsteady and turbulent, which could cause additional air binding problems. An air release device positioned just below the change in slope normally will remove air accumulations. The single easiest way to avoid air binding problems is to use a transport line one size larger than the siphon itself. Note: for large siphons same size may be ok. Even on a very steep slope, using a transport line the same diameter as the siphon is not advisable, since turbulent, unsteady flow may be encountered. Air binding also occurs when a transport line has a "belly", i.e., a section of pipe that is always full of liquid. Some type of venting is necessary following a "belly." In a transport line where a long section of the bottom of the transport line is flat, a belly may be inevitable. To avoid having to fill this section of pipe each cycle, the system designer may purposely make this section of pipe lower than the discharge point. However, this situation should be avoided whenever possible.

The first step in specifying a siphon for a pressurized system is to verify that the elevation difference, or fall, is adequate to provide the desired pressure at the disposal location. Second, the flow rate required by the distribution network or splitter is determined. In general, the siphon selected should have an average discharge rate higher than the flow rate necessary to pressurize the system. Next, the transport line size is selected, generally one pipe size larger than the siphon size. Depending on the length and slope of the transport line, siphons of six inch diameter and larger may not need a larger transport line size. Again, Manning's equation may be used to help in this determination. The transport line volume and any dis-

tribution network volume that is necessary to provide the desired pressure is then calculated. This piping volume is important in determining the dose volume needed to achieve the desired system pressurization. It is possible, using calculus, to roughly approximate the minimum dose volume required to reach the system design pressure. Using generalizations or "rules of thumb" for the required dose volume is not good practice. Calculations should be performed for each system. A method for performing these calculations is presented in a separate paper. Finally, using the dose volume and the dimensions of the siphon chamber, the drawdown depth is calculated.

Venting

There are three common methods of venting siphon systems. An open standpipe is the most frequently used. Air release valves—with carbon filters for odor control—can be installed on transport lines where an open standpipe is not acceptable. A transport line that has trapped air may also be vented back to itself at a higher position. Most siphons are manufactured with an integral air vent, for venting the air trapped beneath the bell. A vent should always be installed just outside the siphon chamber, usually where the pipe size is increased.

When a system is installed, the transport line <u>should not be buried until proper operation has been verified.</u> Access to the pipe is essential if additional venting becomes necessary. If low flow rates suggest that air entrapment is occurring, a portable drill with a 1/8th inch bit is useful for finding the locations of the air pockets. If a hole is drilled and air is not released, the hole is easily plugged with a stainless steel tapping screw.

Monitoring Devices

Monitoring of a single siphon is usually done with a float switch connected to a battery operated digital counter. The float, installed in the dosing chamber, is positioned to activate near the on level of the siphon. If the siphon fails to cycle (trickles), the liquid level in the tank will not reach the on position and no cycles will be recorded. Alternating siphons can be monitored using the same counter described above, with the addition of another counter in one of the drainfields. The float for the drainfield counter is contained in a small canister that is connected to a drainfield lateral. When the drainfield is dosed, the canister fills with liquid, raising the float and activating the counter. In a properly operating alternating system, the dose counter in the tank records twice as many doses as the counter at the drainfield. Siphon monitors are a quick, easy method of checking siphon performance and are recommended for all siphon systems. High water alarms are not useful since siphon failure does not result in a high water condition.

Maintenance

Maintenance of siphons is limited mainly to checking for proper operation. Dose counters are recommended on all siphons for this purpose. Counters should be checked monthly and a written record kept. Siphons that lapse into a trickling mode can usually be put back into operation by blowing air under the bell or by lowering the liquid level in the tank below the bottom of the bell. Two inch vault-mounted siphons need only be lifted enough to expose the bottom of the bell. Note that as the siphon chamber is filling, liquid is forced out of the siphon trap into the discharge pipe. This flow should not be confused with trickling mode.

If filters or screens are installed, they should be inspected periodically and cleaned as necessary.

FLOUT

Flout stands for "Floating Outlet".

It's a new way to flood septic system effluent into the leach field. It floods the distribution box with water well above the invert of the leach pipes, and insures an equal, fast flow of water down all legs of the leach field.

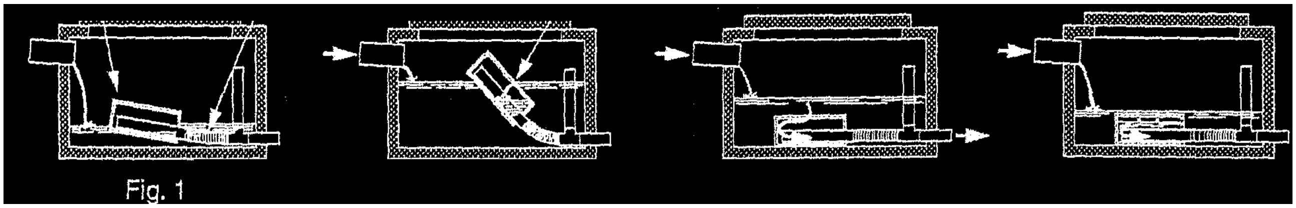
What does it do?

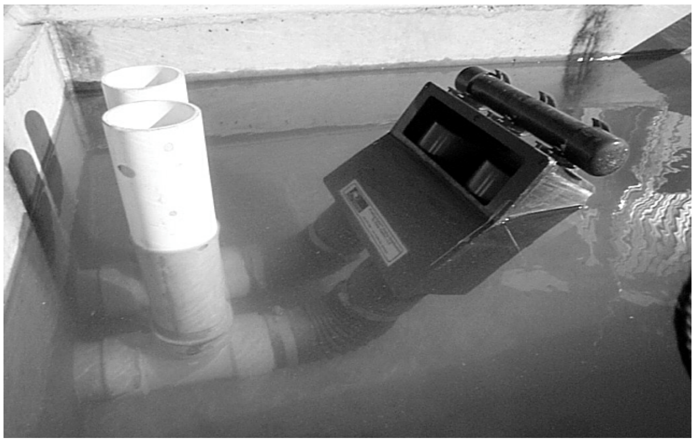
It holds back the water coming from the septic tank until enough is collected to flood the leach field. When the discharge cycle starts, all the stored water is fed to the D-box and flows out every leg of the leach field. After discharging is completed, the septic tank water is held back until another full charge of water is collected. This gives the leach field time to rest and absorb the water that has flooded it. The flooding action insures the entire leach field sees water every time the tank discharges utilizing more surface area of the soil to treat the septic effluent than that of a standard trickling leaching system. If you have a 300-gal charge, 200' of 24" wide leach field, each square foot of trench bottom will average only .66 gallons of water per discharge.

How does it work?

Gravity powers the system so no pumps are required. The Flout body acts like a boat hull and floats up on the surface of the water as the dousing tank fills. It is attached to the tank discharge pipes by a flexible coupling, allowing the Flout to lift off the tank floor in an arc as the water level rises in the dousing tank. The rising of the Flout prevents any water from flowing out to the leach field. When the water level is high enough, it over flows into the Flout body, causing the Flout to loose buoyancy and sink to the bottom of the tank. This action opens a direct path for the water to flow out of the tank and into the leach field. The flow of water fills the leach field pipes at a rate of 65 gallons per minute (per 3" outlet). When the water level falls below the edge of the Flout body, the water remaining inside empties (selfbails) by draining into the leach field, allowing the Flout to regain buoyancy and float up off the floor of the tank, once again blocking water from flowing out. The cycle now restarts as water trickles in from the septic tank and is held back from the leach field as the Flout floats up.

HOW IT WORKS
As effluent from the septic tank fills the chamber, the Float is empty and buoyant and floats on the surface. Flexible connectors allow the Float to rise. When the effluent reaches the maximum level in the chamber, ii spills into a hole in the top of the float. This causes the float to sink. The effluent in the chamber discharges through the pipe(s) which exit the Float, dosing the septic field while providing equal distribution through each outlet, the chamber continues to empty down to the top of the Float. Then the Float empties and resumes floating to repeat another cycle.





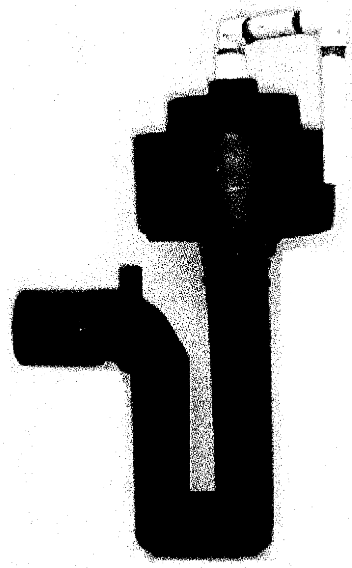
What makes the flout different than a Bell Siphon?

It's easier and faster to install than a bell siphon and requires no special forms to build. Handling and onsite installation is accomplished using the same equipment required to set a septic tank and all work done at the same time the septic tank is delivered. The Flout tank can be leveled quickly and accurately. Any precast septic tank supplier can easily modify tank forms they already own, build a few and then return to building the regular products, on short notice. A contractor can install the flout tank in about an hour and wastes no time leveling the outlets of a d-box. The flout is glued in place inside of the dousing tank (at the precast plant) and delivered on site, ready to install in the ground. The excavated hole for the tank requires a simple flat bottom. 3" or 4" adapter connection pipes can be cast into the tank wall, as per your customer requirements and connection to the D-box is by the installation contractor. No more "grouting in" bell siphons on the job site. No priming water ever needs to be added to the flout for correct operation. Connection to the D-box is just as easy as gluing PVC pipes together. For those big jobs, any number of outlets may be installed in the tank, even or odd number as required. For large dousing applications, additional holding tanks can be paralleled to the dousing tank increasing water, volume per discharge.

For more information call 1-800-479-6335

Web site   www.sunnycrest.com/flout

AMERICAN AUTOMATIC SIPHONS

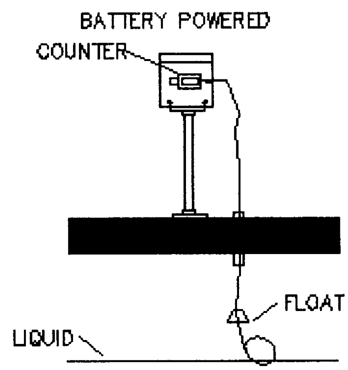


SIMPLEX (ONE)
An inexpensive trouble-free method of providing dosing and resting is through the use of an automatic siphon. There is an automatic dosing siphon available for a wide variety of dosing tank and drawdown depths.

DUPLEX (TWO)
Longer periods of rest can be provided by installing two siphons in the dosing tank and alternately discharging the tank into one-half of the field at a time. The american siphon is hydraulically designed to automatically alternate when two siphons are installed. This is accomplished with no moving parts as it relies upon the hydraulic design of the siphon.

OPERATION OF AUTOMATIC SIPHON

When the liquid rises in the tank above the open end of the vent pipe affects an air seal. As the liquid continues to rise air trapped in the dome and the long leg of the main trap forces water out of the trap. When the head of the liquid in the tank forces all of the long leg of the trap a quantity of air will be forced around the lower bend. Liquid in the short leg of the trap will be rapidly forced out of the short leg by the up rush of air and will start the siphon action. The liquid is drawn out of the tank until air reaches the bottom of the dome which stops the siphon action.



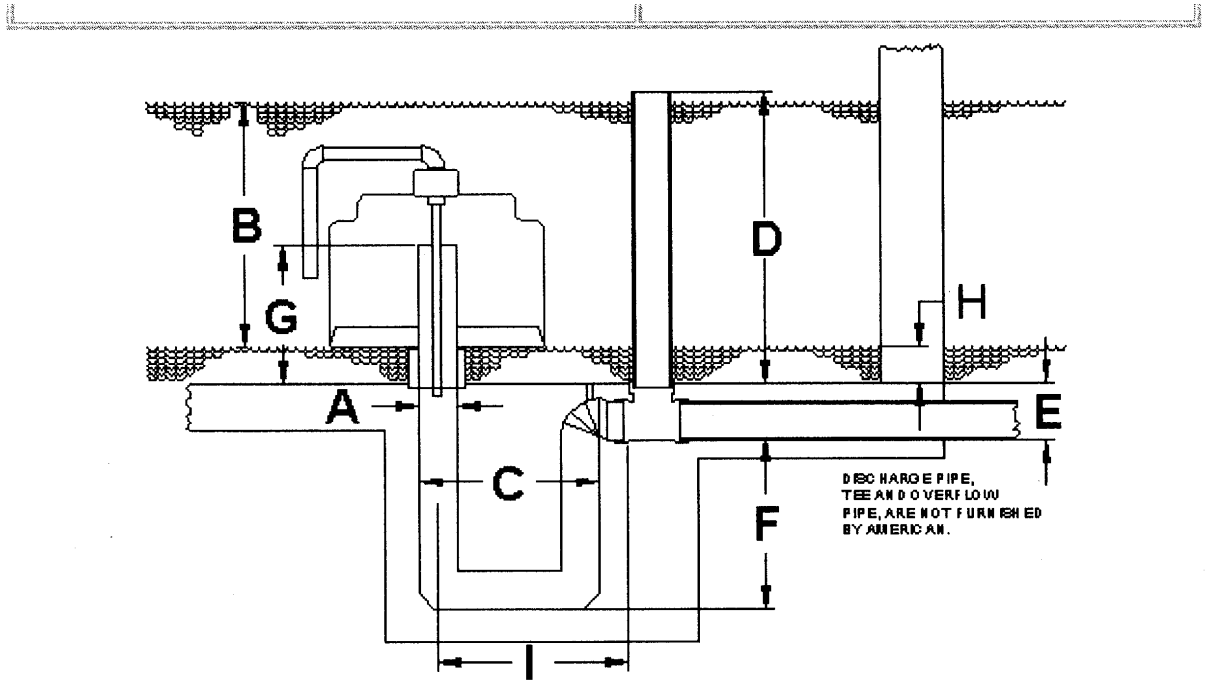
SIMPLEX SIPHON CYCLE COUNTER

Part No.
Description

SSCF-GL
SIMPLEX SIPHON CYCLE COUNTER

DSFS-GL
DUPLEX SIPHON CYCLE COUNTER

The Battery operated siphon counter has a 5 year battery life design. The counter comes in a NEMA 4X enclosure with a non-mercury differential float switch. Dual siphon counters are provided with two counters and two flow switches.



APPROX. DIMENSIONS IN INCHES

SIPHON MODEL NUMBER		**207**	**313**	**413**	**417**	**423**	**523**	**630**	**836**
SIPHON DIA.	A	2	3	4	4	4	5	6	8
DRAWDOWN	B	7	13	13	17	23	23	30	36
WIDTH OF TRAP	C	6.6	8	10.5	10.5	11	13.3	16	20
HIGH WATER ABOVE FLOOR	D	9	16	20	20	26	26	33	39
FLOOR TO DISCHARGE	E	3.4	4.5	5	5	5	7.8	10	8.5
TRAP DEPTH	F	6.4	11.5	12	15	15	20	30	30
HEIGHT ABOVE FLOOR	G	5	12	9	11	16	12	15.1	25.5
BOTTOM BELL TO FLOOR	H	2	3	3	3	3	3	3	3
TRAP TO DISCHARGE	I	N/A	10.5	16.5	16.5	16.5	19.5	22	26.5
AVG. DISCHARGE G.P.M.		30	72	140	150	160	325	450	900
MIN. DISCHARGE G.P.M.		25	48	100	100	100	230	350	450
APPROX. WEIGHT (LBS)		**6**	**7**	**12**	**13**	**14**	**17**	**31**	**57**

AMERICAN MANUFACTURING COMPANY, INC.

Last revised: Oct-14-2002, Comments to: info@americanonsite.com

Copyright ©, American Manufacturing Company, Inc., 2000

http://www.americanonsite.com

Orenco Systems, Inc.

Web site www.orenco.com

3 in. and 4 in. Dosing Siphons

Orenco's Dosing Siphons can be used as an alternative to pumps when dosing downhill. Flow rates can range from just a few gallons per minute to several hundred gallons per minute, depending on siphon size. Dosing siphons use no moving parts. Counters are used to monitor siphon operation.